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ABSTRACT

GRADES OR AGES: Grades K-6. SUBJECT MATTER: Science. ORGANIZATION AND PHYSICAL APPEARANCE: This guide has been organized according to grade level. Introductory materials indicate the basic approach and the major objectives for science education. Each unit is divided into two columns: skills and concepts and activities and resources. Materials for each grade are organized under three broad topics: universe and earth, living things, and matter and energy. Elementary Science Study (E.S.S.) units have been incorporated into this guide at appropriate grade levels. The guide is lithographed and spiral-bound with a hard cover. OBJECTIVES AND ACTIVITIES: The objectives for each unit are listed under skills and concepts. Detailed activities are suggested. INSTRUCTIONAL MATERIALS: Films and books are listed under activities and resources. STUDENT ASSESSMENT: No provisions are made for evaluation. (MJM)

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ELEMENTARY SCIENCE

CURRICULUM AND RESOURCE GUIDE

1969

INDEPENDENT SCHOOL DISTRICT 621
Mounds View Public Schools
District Service Center
2959 North Hamline Avenue
St. Paul, Minnesota 55113

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SP007347

Superintendent Sanford C. Witter
Board of Education
Mounds View Schools

Gentlemen:

This completely new Elementary Science Curriculum has been developed for the use of teachers in all elementary schools. Previous district curriculums in science had been introduced in 1958, 1961, and 1967.

This most complete curriculum has come in large part from the work of our district science curriculum committee, first organized in the school year 1965-66. Their results, plus the valuable help secured from very recent science curriculums of the country, many of which I personally examined and ordered while at the National Association for Supervision and Curriculum Development Convention at Chicago last spring, furnished a good starting point for our hard working writing team this summer.

After first reading "Science Education - A Point of View", notice the four big objectives of this guide. Notice that materials for grades one through six are organized under three broad topics which have been color coded for greater convenience in following through on the topic. The committee also put in some Elementary Science Study (E.S.S.) Units as a starter, realizing that many more will be recommended by our district science committee during the coming school years.

There is a need to continously improve teaching and learning in science. New materials of instruction, new teaching approaches and the continuing responsibility to meet the individual needs of students place great demands on all professional staff members to appraise the quality of teaching and learning in science. This publication represents an effort on the part of staff members within our school system to assist all staff members in improving the teaching and learning in science. It is hoped that all teachers who use this publication will find it to be of value.

Clayton O'Hagan
Director of Elementary Education

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INTRODUCTION

This guide to the teaching of science in the elementary school has been written for the purpose of organizing curriculum content and for directing teachers in classroom instruction activities.

The Science Curriculum is divided into three areas: the universe and earth, living things, and matter and energy. New science programs propose to develop individuals who have knowledge of basic science concepts and are able to apply these skills in analyzing and solving scientific problems both of the present and the future.

It is hoped that these materials will assist the teacher in meeting the instructional needs of elementary school pupils in the area of science.

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SCIENCE EDUCATION - A POINT OF VIEW

Introduction

Science is an organized activity through which man seeks explanations which best correlate with the observations of natural phenomena. The essence of this activity is in large part the manner in which knowledge is derived rather than limited to knowledge itself; i.e., the manner in which man acts while in contact with that which is unknown. It is within this concept of science that a science instructional program should meet its responsibilities to the total educational experiences of young people, and in turn to the needs of out evolving society.

The central purpose of science education is to awaken in the child, whether or not he will become a professional scientist, the joy in the search for knowledge, the excitement in seeing into the workings of the physical and biological world, and the intellectual power to be gained in learning the scientists process of inquiry.

Science education should make its greatest contribution to the total educational program in the area of critical thinking and the process of inquiry. Through this sort of development a person is prepared not only for today's problems but also for those of the future when inquiring and flexible minds will continue to be needed to recognize new problems, to discard obsolete and irrelevant information and to adapt to new situations. It is recognized that problem-solving is not unique to science but basic to all human endeavor; however, science does lend itself to the development of skills and processes necessary for problem solving.

1. Responsibilities of Science Education to the Individual and to Society

The individual is the basic element of a democratic society. It follows that satisfying the responsibilities of education to the individual will also satisfy the responsibilities to society. There is some reason for the hope that critical and inquiring minds will be capable of putting society in order.

Tradition has, to some degree, led toward teaching in a way that tends to develop technicians and specialists. Although we must not neglect those who will become specialists in science, it is desirable to fulfill the very real and enduring needs of the large majority of children. Our world and its societies are becoming more influenced by and more reliant upon scientific developments for their progress. Many political and social problems are complicated by advances in science and their solutions will depend, at least partly, upon understanding and appreciation of science and what it can do. In turn it seems necessary that science use its own methods to question and criticize itself. There is no guarantee that man will wisely use its technical accomplishments.

Science education, and educational endeavors in general, should continually look toward ways of coping with these problems while recognizing that the rate of basic discoveries in science as well as in political and social studies will greatly increase in the future. In solutuions to these problems the needs and resources of local communities should not be overlooked.

II. An Approach in Science Education

In order to satisfy the previously mentioned responsibilities, it seems that, at least in part, science should be taught as a procedure of inquiry. If individuals are to be able to recognize and ask pertinent questions; then methodically pursue answers, the curricula and teaching methods used must reflect this. These must take into account the importance of individual development, must provide the student with opportunity to explore, experiment, inquire, and draw conclusions, including incorrect ones. It must not be forgotten that the history of science is a history of people finding their way out of established errors. Science is taught not only by talking about it but by allowing the students to become involved in it.

This inquiring approach should result in accumulating proficiency in the ability to utilize the process of scientific inquiry as the students progress through grades K-12. They should learn to approach their investigations in a sequence of stages associated with these processes. Although a number of terms could be used to describe these stages, the following do represent their intent.

Organizing:	Identifying the area and scope of the problem at hand in which primary pertinent questions are asked to lead into a sequential series of investigations. The problem is reduced to the one or more questions forming the basis of the problem. A set of supplemental questions raised for each of these primary questions leads into a series of related activities with proper consideration of controls and variables that provide data appropriate to the problem.
Observing:	Gathering specific and accurate observations relative to the original questions.
Tabulating:	Recording observed data accurately and systematically without efforts to explain.
Analyzing:	Scrutinizing the recorded data, comparing phenomena, perceiving differences and similarities among events, and seeking evidence and proof of relationships and patterns of behavior.
Extracting:	Screening and selecting information revelant to the primary question.
Assimilating:	Absorbing this information; modifying, expanding, or transforming previously held notions and ideas.

Applying and Predicting:	Connecting and relating this assimilation to the student's world; practically intellectually, and culturally. This stage of application may lead to predictions about environment initiating a renewed cycle of the investigative processes of inquiry.

The emphasis that should prevail throughout elementary school is that of developing the skills, operation, and attitudes of scientific inquiry. This cannot be done without subject areas in which to think and work. Knowledge of these areas, although not of primary concern, need not be neglected. A student experienced in this process of inquiry as presented during his elementary education will be prepared to continue his science education at the secondary level with an added emphasis.

The added emphasis or concern in the secondary science program is for the identification and recognition of concepts held in common by all science; conceptual schemes. These conceptual schemes are not intended to be final statements of authority but are subject to further investigation and possible change. As thus developed these schemes can be utilized as a possible vehicle through which processes of scientific inquiry can be further developed.

III. The Major Objectives of Science Education

Educational objectives are statements about the attitudes and behavior expected of students after they have participated in the experiences provided for them in a science program. The objectives are vital as criteria for the selection of content, materials, teaching methods, and the types of experiences afforded the student. Objectives of science education are also vital to any science program in-that they form the basis for the evaluative procedures utilized. It follows that if the objectives are stated clearly with the specific outcomes regarding attitude and behavior of the student defined, the task of evaluation is made somewhat easier. This is not always possible, but wherever it is, specific statements are desirable.

A student who has attained the major objectives of science education should:

1. be able to apply an extensive knowledge of science facts, concepts, and skills in an attempt to solve original problems and understand phenomena encountered in his environment.

2. understand the basic principles of science and habitually use the processes of inquiry in the solution of problems.

3. recognize the present position, applications, potential and limitations of science in today's world.

4. be aware of the joy, the excitement, and the intellectual power of science and have generally favorable attitudes toward science.

Although the following is not a complete list of attitudes, behaviors, and skills which would indicate attainment of these major objectives, it does represent some of the more important ones.

A student should:

1. have a sense of judgment which is suspended, critical, and evaluative.
2. have a sense of intellectual honesty.
3. be able to think critically and quantitatively.
4. be able to communicate precisely.
5. be able to observe, question, and experiment systematically.
6. be able to analyze and solve problems rationally.
7. be able to form generalizations logically.
8. be able to work independently with a minimum of supervision.

Material from pages II-V obtained
from the State of Minnesota - Department of Education

OBJECTIVES OF THIS GUIDE

1. To present the teaching of science in an organized and sequential manner.

2. To identify the skills and concepts to be introduced at each grade level.

3. To list suggested activities for the teaching of specific science concepts.

4. To provide a partial listing of resource materials and aids which are found to be advantageous in the teaching of science concepts.

GUIDE BOOK ORGANIZATION

This guide has been organized by grade level. Materials for grades one through six are organized under three broad topics which have been color coded for your convenience as follows:

Universe and Earth	Pink
Living Things	Lemon
Matter and Energy	Blue

SCIENCE OUTLINE

I. Universe and Earth
  A. Outer Space
  B. Solar System
  C. Sun
  D. Moon
  E. Earth
    1. The Planet
    2. Geology
    3. Oceanography
    4. Water, Weather, and Air
  F. Planes, Rockets, and Space Travel

II. Living Things
  A. Plants
  B. Animals

III. Matter and Energy
  A. Matter
  B. Energy
    1. Mechanical, Chemical, and Nuclear
    2. Heat and Light
    3. Sound
    4. Magnetism and Electricity

E.S.S. UNITS

The following Elementary Science Study (E.S.S.) Units have been incorporated into this curriculum guide at appropriate grade levels.

Kindergarten
- Lights and Shadows
- Eggs and Tadpoles
- Mobiles
- Attribute Games and Problems

Grade One
- Growing Seeds
- Primary Balancing
- Spinning Tables
- Mirror Cards
- Pattern Blocks

Grade Two
- Sand
- Changes
- Structure
- Tangrams

Grade Three
- Where is the Moon?
- Ice Cubes
- Brine Shrimp
- Sink or Float

Grade Four
- Animal Activities
- Bones
- Mystery Powders
- Pendulums
- Batteries and Bulbs

Grade Five
- Rocks and Charts
- Balloons
- Pondwater
- Small Things
- Mealworms
- Colored Solutions
- Budding Twigs

Grade Six
- Gases and Airs
- Microgardening
- Crayfish
- Kitchen Physics
- Peas and Particles

MINNEMAST UNIT I

WATCHING AND WONDERING

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. An explorer is a person who must look at things very carefully and ask many questions in order to find out all he can about a discovery and be able to tell others of it. Children should be encouraged to look at things with a questioning and wondering mind in an analytical way.	a1. Encourage the children to examine an area or object in the classroom. Ask them to tell how they would describe it, telling about its material, color, use, texture and size. Tell how it is different from and similar to other objects that the child has seen.
	a2. Explore other parts of the school alerting the children to special things they may wish to look for and point out things which they may have missed.
	a3. Have child say, "On my visit to the kitchen I saw . ." listing all the things they saw until they make a mistake.
	a4. Play "I saw a broom; where did I see it?" Whoever gives the correct answer may make the next observation.
	a5. Read the story "Ollie and Jay".
	a6. Explore the area around the school and other types of areas including woody areas, grassy areas, and bog or water areas and collect specimens such as seeds, leaves, weeds, insects, or other animals. Later discuss the various areas and compare them. Discuss how each might be used and what activities might be undertaken in each.
	a7. Collect and compare soil samples from areas visited and feel their texture. Discover whether there are any plants or animals in the water by adding water to the sample and noticing whether any material floats to the surface.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
b. To predict what is going to happen or what is going to be seen.	b1. When a box or other object is brought into the classroom ask the children to guess what it contains.
	b2. When a new object has been added to the room or a change has been made in the classroom, ask the children to be detectives and see if they can discover what is new.
	b3. Set up a display of items relevant to a holiday, season or subject the children are studying and provide opportunities for the children to observe it.
	b4. Encourage the children to look around the classroom and see if there are any objects that they have never noticed before.
	b5. Read the story "The Day Watchman" in which a little girl visits a park and examines a dog. She discovers many things about the dog using the senses of touch, hearing and seeing.
	b6. Read the story "The Bird and the Worm" which asks the children to predict what is going to happen next in the story.
c. To learn to test assumptions.	c1. Discuss how thumbs help one in doing things. Try to do various things using your thumb and not using it. Discover how animals, who do not have thumbs, pick up objects.
	c2. Provide an opportunity for the children to observe several objects such as a ball, cotton, feathers, dandelion, or mildweed seeds, a balloon and a paper airplane falling to the ground. Hold an object in one's hand and ask the children "Why does that object not fall to the earth?" The teacher is holding the object up. Discover that air holds up objects such as balloons, airplanes, and birds.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	c3. Ask the parents of the children to take them outside at night to observe the "night life" of the neighborhood. Encourage the children to report to the class about the animals they have seen and heard during their observation.
	c4. Read the story "Five Reasons For a Cat", in which two children are required to list five reasons why the family should acquire a kitten. The children in the class are asked to think of reasons why the family should get the cat.
	c5. Read the story "The Night Watchman" which tells of a little man who wonders about things. It encourages the children to wonder about things.
d. To use the phenomena of weather to lead the child to make observations, provide descriptions, originate questions, and attempt to find answers.	d1. Discuss weather briefly each day and keep a record of the weather by pasting symbols on a calendar and counting the number of days having a particular type of weather.
	d2. Read poems about the weather and encourage the children to make up their own poems.
e. Air is always moving. One cannot see the wind but only its effects.	e1. Go outside on a windy day and notice the effect of the wind on oneself. Help the children to realize that they cannot see the wind, only its effects. Observe what the wind is doing.
	e2. Have the children run with the wind and against the wind holding paper streamers. Observe what happens to the paper streamers that the child is holding.
	e3. The movement of a tree can be used to estimate wind velocity. Only leaves and small twigs move when a gentle breeze blows. Larger and larger branches blow as the wind velocity increases.
	e4. Discover that air has pressure and occupies space by blowing up a balloon and letting the air out.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	e5. Fan or blow a styrofoam ball on a table. Observe that fanning and blowing have the same effect.
	e6. Drop two sheets of paper to the ground, one of which has been crumpled into a ball. Discover which sheet reaches the ground first and why, and what is holding the other up.
	e7. Discuss why a breeze is felt through the window of a car, even on a still day.
f. To observe the various forms, colors, and movements of clouds and recognize familiar shapes.	f1. Observe what kind of clouds are visible before a rainstorm and by looking at the clouds try to determine whether it is going to rain. Are clouds always present?
	f2. The children may make cloud pictures from construction paper. Cotton clouds may be colored with chalk to represent weather conditions.
	f3. Children may learn to identify certain cloud formations.
g. Rain Determine how different types of weather are alike and different.	g1. Observe the rain as it falls, feel it with your hands and faces, and listen to it as it splashes against objects. Observe the sky and the direction from which it is falling. Be aware of the wetness and coolness of the rain, the smell of the air and grass during a rain, and the variety of sounds the rain makes when it hits different objects.
	g2. Touch objects exposed to the fog. Discover whether it is rainy when there is fog. Can the sun be seen when there is fog? Children can make their own fog by breathing out into the cold air.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
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	e3. The movement of a tree can be used to estimate wind velocity. Only leaves and small twigs move when a gentle breeze blows. Larger and larger branches blow as the wind velocity increases.
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	e7. Discuss why a breeze is felt through the window of a car, even on a still day.
f. To observe the various forms, colors, and movements of clouds and recognize familiar shapes.	f1. Observe what kind of clouds are visible before a rainstorm and by looking at the clouds try to determine whether it is going to rain. Are clouds always present?
	f2. The children may make cloud pictures from construction paper. Cotton clouds may be colored with chalk to represent weather conditions.
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	g2. Touch objects exposed to the fog. Discover whether it is rainy when there is fog. Can the sun be seen when there is fog? Children can make their own fog by breathing out into the cold air.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	g3. Observe dew and frost and determine the conditions present when it occurs.
	g4. Observe snow, discovering how it feels and looks. Collect a pan of snow and let it melt. Note the small amount of water that comes from the pan of snow. Look at snowflakes with a magnifying glass.
	g5. Read the story "Picnic at the Beach". This story is about clouds and illustrates the development of a storm.
h. To observe, report, and speculate about the night.	h1. Discuss and list the differences between night and day. Describe the nighttime sky as to its color, whether this sky is completely dark, and what the moon looks like. Discover why it gets dark and what happens when it gets light.
i. To observe the sun.	i1. Observe the sky during the daytime. Discuss the source of light and determine that the sun appears to be in different places in the sky during the day. Encourage the children to observe where the sun is in the sky in the morning, at noon, and in the evening.
	i2. Note the amount of daylight during the winter and other seasons.
	i3. Notice the heat and light that is given off by the sun. Discover what animals and plants like to be in the sun.
j. To discover that a shadow occurs when something moves between the sun and another object. The teacher may wish to use the E.S.S. Unit "Lights and Shadows" at this time.	j1. Take children out on the playground in the sunshine. Ask them to observe their shadows. Observe whether the shadow is always in the same position in relationship to the child's body.
	j2. Determine how one's shadow is different from oneself.
	j3. Discover whether one can make his shadow disappear.

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	j4. Discover whether other objects have shadows and whether shadows are useful sometimes.
	j5. Draw an outline of a child's shadow on wrapping paper. Compare the child's shadow to the outline at a different time during the day.
	j6. Discover whether the above activities can take place on a cloudy or partly cloudy day.
	j7. Discover whether shadows can be made inside a building and what types of shadows can be made.
	j8. Make a sundial using a nail and piece of cardboard. Trace the shadow of the nail at various times during the day.
	j9. Read poems to the children about day and night.
	j10. Read the story, "The Lost Shadows of Twitterville", which is about a town where everyone and everything has no shadows and what caused the shadows to finally reappear.

MINNEMAST UNIT II

CURVES AND SHAPES

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. To recognize and construct curves. A curve may be thought of as a path made by moving a point. It may be straight, angular, or round.	a1. Draw several curves on the blackboard. Ask the children what they should be called. Tell them the lines are to be called "curves". Have them draw curves on the board. a2. Draw curves with a five-pronged chalk holder using a different color chalk in each prong. a3. Let the children draw curves on self-erasing slates. a4. Give each child a 4 foot length of string or yarn. Have him make designs with it. Glue it to paper in a design. a5. Recognize curves in art work during art periods. a6. Push small objects over sand. The paths made will be curves. a7. Dip the wheels of a toy truck in water. The tracks it makes when run over the blackboard are curves. List other things that make curves. a8. Observe water running down a window during a rainstorm and realize that it is a curve. a9. Place a mealworm in a pan of corn meal and notice the path it makes.
b. To recognize a curve as simple or non-simple by determining whether it has a touch point or not. A touch point is a point on a curve that you can	b1. Draw several curves on a large sheet of paper. Tell the children they are going to try to locate touch points. See if they can discover what touch points are. Mark points on the curves and ask the children to trace the number of routes

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
move toward or away from in more than two directions along the curve. A simple curve has no touch points; a non-simple curve has at least one touch point.	they could take from each point. If there are more than two routes, that spot is a touch point.
	b2. Draw curves on the blackboard. Have a child find a curve with a touch point. He continues until he misses. Then, another child tries.
	b3. Have children locate touch points on curves on worksheets and encourage them to ask each other how they know a particular point is a touch point.
	b4. Have each child draw a curve and then exchange papers with another child. The other children have to identify the touch points on other children's papers. The papers are returned to the owners who check to see if they are correct.
	b5. Place a long piece of rope on the floor. A child walks the rope and says "touch point" when he reaches a touch point. If the child misses a touch point he must sit down. If he is able to recognize all the touch points, he gets to select another child.
	b6. Draw a curve on the board with a wet sponge. Have a child tell whether it has any touch points before it evaporates. Or, have a child draw a curve. Whoever first says "touch points" or "no touch points" or "simple" or "non-simple" gets to draw the next curve.
c. To know how to classify curves as simple curves or non-simple curves.	c1. Draw a series of simple and non-simple curves on the board and have the children tell you whether they have any touch points.
	c2. Classify a group of cards containing curves as to whether the curves are simple or non-simple.
	c3. Have each child draw a simple and non-simple curve on a piece of paper and encourage him to make a picture from his curve.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	c4. Have the children use pieces of yarn to make simple and non-simple curves. c5. Have children make simple and non-simple curves with their bodies. c6. Have each child draw 8 curves on cards and sort them into simple and non-simple subsets. Each child picks one of his cards and tells the class what type it is. c7. Give each child a worksheet containing 12 curves. The children should cut out the cards and sort the curves into two subsets; one of simple curves and the other of non-simple curves. Children check each other's sortings.
d. To recognize open and closed curves. Closed curves form boundaries between regions and open curves do not form boundaries.	d1. Play the game of "cat and mouse" on the blackboard. One child, "the mouse", draws a curve. A child, who is the "cat", draws the place where he wants to sit. The mouse draws where he wants to sit. The cat cannot cross the curve to catch the mouse. d2. Have each child draw curves on each of eight cards. Use these cards to play "cat and mouse" with a partner. d3. Separate the curves into subsets of closed and open curves. Have the children look at the closed curves and tell them that the mouse has several friends who would also like to hide from the cats. The children should color red the spaces where the mice could hide and blue where they would not be safe. d4. Look at the open curve cards and determine whether there is any place on the card where the mouse would be safe. Have the children color the card blue where the mouse would not be safe.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	d5. Show the children a set of cards and have them classify curves as to whether they are closed or open. Then, have the children classify the curves as to whether they are simple open, simple closed, non-simple open, non-simple closed.
	d6. Draw a concept tree on the board showing the various types of curves. Have the children each draw eight curves and "climb" the tree showing the type of curve they have. Give each child a copy of the concept tree and have him place his cards in the proper location.
	d7. Have the children make curve trains with the curves of different types on them.
	d8. Have each child make either a closed or open curve with string or yarn and then have him make a curve of the other type.
	d9. Sometime when the children are standing or sitting in a closed curve ask them how they may make it an open curve or vice versa.
	d10. Have the children bring in leaves. Study the shapes of the curves of the leaves.
	d11. Read the first part of the story, "Burple the Bug" which illustrates various types of simple curves.
e. To recognize a closed curve as a boundary that divides a plane into regions.	e1. Read the second part of the story "Burple the Bug" which illustrates the idea that a blosed curve is a boundary that divides a plane into regions.
	e2. Have each child draw a closed curve and an open curve on separate pieces of paper. Have them color red the parts of the paper where the mouse would be safe and blue the parts where he would not be safe. The red and blue parts are each regions.
	e3. Have each child draw a figure eight. Now have a dog who wants to catch a cat, a cat

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	who wants to run away from the dog and catch the mouse, and the mouse who wants to run away from the cat. Place each in a region where they would be safe and color each region a different color.
	e4. Place curves of yarn on the floor and see if a child can move an object from one point in the plane to another without crossing the curve. Determine whether there is more than one region and whether the curve is open or closed.
	e5. Place a closed curve of yarn on the floor. Have the children identify the number of regions and the boundary.
	e6. Draw an open curve on the board. Mark an X and Y. Have the children copy your curve with yarn and determine whether one can move from X to Y without crossing the curve.
	e7. Place rope in a looped pattern on the floor with different colors of construction paper in each loop. Play "Simon Says" telling the children to place their feet in certain loops.
	e8. Draw several closed curves on the floor between two points. Tell the children that they are stepping stones that the children must step on in order to keep their feet dry and in order to get from one point to the other. Reverse the activity telling the children that the closed curves now represent puddles and the area between them is dry land.
f. To discover that only part of a non-simple closed curve is actually the boundary which divides the plane into regions.	f1. Make two simple closed curves and two non-simple closed curves. Two pairs of children represent Claudius and Burple in the cat and mouse game. Determine what parts of the curves the Burples need to keep safe and cut off the rest.
	f2. Have children copy a curve made by the teacher. Identify it as to type. Draw two points to represent the cat and the mouse. Let the children tell what part of the curve the mouse needs to be in to keep safe.

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	Color the part of the curve blue that would keep the mouse safe and the part that is not needed.
	f3. Have the children do a worksheet in which they cut off the parts of the curves that they do not need.
g. To change shapes of curves.	g1. Have a row of children make differently shaped curves and tell the teacher what type of curves they represent.
	g2. Have the children make differently shaped simple open curves with clay snakes.
	g3. Children close their curves and change them to the shapes of common objects.
	g4. Draw curves of different shapes on deflated balloons. Then inflate the balloons to see whether the curves have the same shapes.
	g5. Each child makes a simple open curve with yarn, then changes places with another child, checks his curve and tells why it is the right type. They then go back and make a new set of curves and check another person's again. Try this activity with other types of curves.
h. To review the classification of various curves.	h1. Make a concept tree on the floor with masking tape. Have the children line up at the tree and tell which branch they are going to. Another child may have a child's place by drawing a curve of the type where the child is.
	h2. Children cut out curves on a worksheet and place them on a concept tree drawn on paper.
	h3. Pick out of a group of curves the ones that are closed curves.
i. To identify four special simple closed curves: triangle, circle, rectangle, and square.	i1. Make shapes from pipecleaners and have the children identify them.
	i2. Child places an object in a particular shape

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	and tells what type of shape he places it in.
	i3. Share with the children objects that have the shapes of these special simple closed curves.
	i4. Make a bulletin board illustrating examples of various types of curves.
j. To realize that special closed curves also form boundaries that divide a plane into more than one region.	j1. Draw eight curves on the chalkboard and have each group of children copy one of them with yarn on their paper. The curves represent fences which are to separate men from horses. Each group is to draw a horse in one region of his paper and a man in another region.
	j2. Add a new branch to the concept tree for special curves. Draw several curves on small sheets of paper and classify them as to where they go.
	j3. Describe property blocks and have the children identify the block you mean.
	j4. Children may combine various construction paper shapes to make pictures.
k. To be aware that figures formed by the edges of objects represent curves.	k1. Trace around the edges of objects with chalk on the chalkboard.
	k2. Select a piece of furniture in the classroom and describe it in terms of the four shapes.
	k3. Plan Special Curve Days on which children are to notice shapes of a paticular type and draw the teacher's attention to them.
	k4. Stack property blocks of a particular shape and see if the children are able to locate another shape in the structure.
	k5. Read the story "The Triangle Twins," which shows how two triangles may be put together to make a square.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
l. To be aware that different combinations of property blocks may be put together to make a variety of shapes.	l1. Experiment with the property blocks to make a variety of shapes.
m. To see the relationships between regions and boundaries in models and maps that they make.	m1. Use a closed curve of yarn to represent the walls of the classroom and determine where the walls are. Use property blocks to represent the furniture in the classroom.
	m2. Rearrange the furniture in the classroom after having used the blocks as models in determining the arrangement.

MINNEMAST UNIT 3

DESCRIBING AND CLASSIFYING

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOUCES
a. a set is defined as a group of objects having one or more common characteristics or properties. A subset of a set is any selection of the members of that set including all or none of the members. An empty set has no members.	a1. Introduce the words "set," "subset," and "empty set" with sets of objects in the classroom.
b. A set of objects can be divided into subsets according to properties.	b1. Have each child collect a few objects from his home, on the playground, on a walk, or in the classroom. Each child sorts his objects into two subsets and explains his basis for classification to the teacher. b2. Sort varied shapes of pieces of colored construction paper into sets. b3. Read the story, Johnny and the Buttons. In this story a boy works with sets, subsets, and empty sets.
c. Property blocks may be sorted by their properties.	c1. Have a child identify a property of one block. Children select all the other blocks that have that property. c2. Divide the children into subsets. Each subset of children works with a set of blocks. Each group of children selects a property and picks out all the blocks that have that property.
d. Objects may be sorted into two subsets, one that has a particular property and one that does not.	d1. Examine the property blocks noting differences in color, thickness, size, and shape properties. Have a child select a block. Ask the child a property of the block. Ask someone to find another block with the same property. Place them into one of two marked areas on the floor. A child

SKILLS AND CONCEPTS	ACTIVITIES
	selects a third object. If it does not go with the other two objects he places it in the other marked area. Continue until all objects have been placed. Determine the like properties of the objects in each subset.
e. Blocks or objects may be sorted into subsets using each of two properties.	e1. Arrange a subset of thick, red, circular and triangle, and large and small blocks, differing primarily in shape and size. Children sort the blocks into two subsets and state the property of each subset.
	e2. Arrange a subset of blocks including thick red and green, circular and triangular blocks, large and small, and sort them into two subsets and state the properties of the objects in each subset.
	e3. Sort objects such as leaves and seeds into subsets. First, forming two subsets and then forming three subsets.
f. Sets may also be defined by tabulating or listing the members of the set.	f1. List a group of objects in the classroom. That is a set.
g. Conservation of the number property of a set means that a set is the same set if its members are simply rearranged without removing or adding members.	g1. Rearrange the members of a set. Determine if it is the same set. Add a member to the set and determine if it is the same set. Remove or substitute a member and determine if it is the same set.
	g2. Read either Cleaning Up the Classroom or Too Many Toys, which tell how children sorted objects.
h. Set members may be checked against a reference set after rearrangement to make sure all members are there.	h1. As an object is placed in a box, record it by placing a mark on the chalkboard. Or, another identical set of objects may be kept outside the box. Shake the box in which the objects were placed. Compare the set in the box to the reference set. Repeat the above activity stacking blocks in piles, putting them into a basket, or placing them in a line.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	Give each child an object. Have the objects placed in a basket. Ask if the set of objects in the basket is the same set of objects that were held. Determine how the children can tell if it is the same set. Have each child get his own object out of the box.
	h3. Put out a set of property blocks with a reference set including the same blocks. Remove, substitute, or add blocks to the set.
i. Blocks may be sorted by two properties.	i1. Have the children first place blocks with a certain property on a sheet of paper. From this subset, pick those that can be sorted according to the second property, and put those on a second sheet of paper. Determine the properties of each set. Blocks may also be sorted by three properties.
	i2. Make up sets of thick blocks including large triangular, large circular, large square, and small triangular and give a set to each child. The child takes one block out of his bag, keeping it hidden, and states two properties of it. Other children select a block from their bags having these properties. First child holds up his block, others decide whether they chose the right block. Repeat with other children and three properties instead of two.
j. One may need to use all of their senses in order to classify an object in terms of properties that he observes and that others can verify. Classification depends upon separating two objects on the basis that one has the property and the other does not.	j1. Hold up an object and have a child name one property of it. Five other children find five things in the classroom that have the same property. Repeat with a different property of the object and with other objects.
	j2. Have a child select one object from a group and identify a property of the object. Child selects all other objects in the group that have that same property.
	j3. Experiment with various pairs of objects to determine whether they have some properties that are not readily apparent.

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SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	j4. Give each child a bag of objects. Teacher describes properties of one object in the bag. Children have to find object.
	j5. Child selects object in the classroom. Other children try to identify object by asking questions that can be answered with yes or no.
k. Children may learn from their own observations the differences between living and non--living things.	k1. Compare two pairs of living and non-living objects similar in shape, size, color, or softness. Then, compare the living objects. When comparing the two living objects, note and compare their shapes, colors, actions, and body parts.
	k2. Take a field trip near the school and observe the different ways in which animals move and the use of their body parts in moving a particular way. Classify animals seen on the trip by the way in which they move
	k3. Sort pictures of animals into sets of those who fly and those who do not. Pictures may also be sorted into sets of those who walk and those who do not.
l. Sets may be compared by pairing their members in one-to-one correspondence. The sets may be equivalent but not necessarily equal. Equivalent sets have the same number of members. Equal sets have exactly the same members. A set which is not equivalent is an incompletely paired set.	l1. Work with sets of children and other objects in the classroom to discover what one-to-one correspondence is and what equivalent sets are.
	l2. Place two rows of blocks on the floor. Use chalk lines, yarn, wire, string or sticks as connectors between the paired members. Children may indicate which set they think has more members before the pairing is done.
	l3. Substitute new objects for old objects in a set. This will not affect the one-to-one correspondence between sets.
m. A subset has no members that are not members of the set. An empty set is a set with no members in it.	m1. Use the children in the class as a set and the boys and girls as subsets. Items or colors of clothing may also be used to distinguish subsets.

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SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
n. There is a connection between an action with concrete objects and the representation of these actions in a diagram.	n1. Place a bead in each section of an egg carton. Determine that the set of eggs is equivalent to the set of spaces. Draw a diagram of an egg carton on the board with a set of eggs. Draw a line between each egg and its space. n2. After drawing connectors between two incompletely paired sets, circle the set that has more members. Have the children draw sets and pick other children to draw the connectors. n3. Sort property blocks into subsets by various properties. n4. Display a set of blocks. Ask the children to draw various subsets of the group and display their subsets.

MINNEMAST UNIT 4

USING OUR SENSES

KINDERGARTEN

SKILLS AND CONCEPTS		ACTIVITIES AND RESOURCES
a. To differentiate between the kinds of information provided by each of the senses and to realize that one may make value judgments about sense impressions.	a1.	Pass an object such as a coconut around the group. Ask the children to tell about it. As they discribe the coconut ask them what senses they used in determining each property of the coconut continuing until all senses have been mentioned. Also do this with other objects.
	a2.	Each child states which fruit or flower he likes best and tells why. These are value judgments and show that individuals differ in their reactions to the same impressions.
	a3.	Read the first part of the story Jeff's Dream.
b. Two properties that can be observed using the sense of sight are color and shape.	b1.	Have one child stand in front of the class while the rest of the children have their eyes closed. Ask the children who is standing in front of the class. Tell them to use the sense that will tell who it is. Have another child stand in front of the class. Ask the children whether it is easier for them to tell who it is when there eyes are open or shut.
	b2.	Draw a circle on the chalkboard and have the children name objects that have that shape. Hold several objects circular in shape up and ask the children what they need to know in order to determine which object it is. Repeat this with other objects and shapes.
	b3.	Provide visual objects about some object in the classroom and have the children identify it.
c. If there is a visual obstruction, an object can not be seen. External in-	c1.	Display a group of objects. Children close their eyes and tell you what object you are holding up. Child holds 2' by 2' sheet of cardboard in front of his face. Child

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
fluences may change the stimulus the child receives. The child must consider the conditions under which his observations are made.	discovers cardboard blocks his vision just as his eyelids did. Determine what some objects would be that you would be able to see through.
	c2. Show the children an outline of an animal. Place pieces of colored cellophane over it. Determine that the rabbit has not changed but its appearance has changed.
	c3. Read the story Look's Adventure in which Look is very frustrated because the other senses are not present.
d. There is a great diversity of sounds. Sound sources may be identified without seeing the objects that produce them.	d1. Children close eyes for a few minutes and describe the sounds they hear. Have children tell what made the sound, where the sound came from whether it was loud or soft, and whether it was pleasant or unpleasant.
	d2. Teacher makes various sounds and has the children identify them.
	d3. Have children produce sounds by tapping patterns with a pencil. Each child repeats the patterns of those before him and makes up his own patterns.
	d4. Arrange a display of sound-producing objects on a table. Children may experiment with them. One child makes a sound with an object while another child is not looking. The second child holds up the object that he thinks the first child used. Repeat with other children.
e. Objects have to vibrate in order to produce a sound.	e1. Ask the children if anyone knows how to make a sound with a rubber band. Cut the rubber band and have one child hold it while the other plucks it. The rubber band vibrates. Note that the rubber band does not vibrate unless it is plucked. Encourage the children to feel the vibrations of their voice boxes.

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SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
f. Changes in pitch can be made.	f1. Children pluck on string on the autoharp. Call their attention to the vibrations that they can see and feel. Tighten and loosen the tension of the string noting the fall and rise in pitch.
	f2. Tap a glass with a pencil. Place a small amount of water in the glass and tap it again noting that the pitch has changed. It becomes lower as more water is added to the glass. Try putting different amounts of water in each of several glasses.
	f3. Read the story Hear.
g. There are many odors in one's environment. An odor is carried by something from the objects through the air to the nose.	g1. Pass articles around the class that have definite odors such as bananas. The children name the sense organ that tells about odor. Children list descriptive words that may describe different kinds of odors.
	g2. Place objects that have odors in boxes covered with cheesecloth. Have the children identify each odor.
	g3. Wrap one of the mystery boxes in plastic. Discover that the plastic keeps the odor from being smelled. Learn that one can also keep from smelling something by holding his nose.
	g4. Odors may serve as clues to something that has happened or to a place that one might be near.
	g5. Read the story Smell's Adventure.
h. Foods have four basic tastes including sweet, salt, sour, and bitter. Some things have a combination of tastes.	h1. Give children samples of foods having the four basic tastes. Determine which taste each item has. Provide items with combinations of various tastes.
	h2. Discuss value judgments as they concern the tastes of various subjects.
	h3. Read the story Taste's Adventure.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
i. Texture and shape may be identified by using one's sense of touch.	i1. Show the children an object with a definite texture and shape. Ask the children to tell about the object by telling what each of their senses tell about it. i2. Blindfold children and have them each place die-cut geometric shapes in the holes in which they belong.
j. The sense of touch involves physical contact with an object.	j1. Place an object on the table and determine whether it is necessary for the children to have physical contact with the object in the use of all five senses. j2. Provide each child with a bag of objects. One child describes an object in his bag while the other children try to find a similar object in their bags. When all think that they have identified the object they may hold it up. Repeat with other children. j3. Read Touch's Adventure.
k. The senses are interdependent upon each other.	k1. Read the children riddles about various senses and have them identify the senses. k2. Give a child a matched pair of objects. See if he can identify the objects by using only one of his senses at a time. k3. Place an object in a paper bag. See if the children can identify it by hearing, smelling, feeling, tasting, and seeing it.
l. A particular sense is associated with an appropriate sense organ.	l1. Show the children two blocks, one which pictures the senses on its various sides and the other which pictures various objects. Children roll the blocks. If a cat and a hand would come up this would mean that one can feel a cat's fur with one's hand. l2. Ask the children riddles about various senses naming in the riddles the senses to be used in identifying the objects. The teacher may show the children pictures that answer the riddles.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	13. A popcorn party will involve all the senses studied about in this unit. 14. Read the story Wake Up.

MINNEMAST UNIT 5

INTRODUCING MEASUREMENT

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. To compare two objects and determine which has the greater or lesser length.	a1. Place two strips of paper the same length on a flannel board. The children will discover that in order to show that two objects have the same length both ends must be lined up with nothing left over.
	a2. Give each child eight strips of paper. Urge each child to take two strips at a time and compare them as to length. Children show their methods of comparison.
	a3. Children can also compare the lengths of pairs of objects in the classroom and between pairs of Minnebars.
	a4. Play game "Giant or Dwarf" in which each child is given 6 strips of paper or Minnebars. Each child takes one of the strips and compares it with his partner's. Whoever has the longer strip gets to keep both.
	a5. Ask someone to find an object shorter than or longer than a given object, or in between two objects in length.
	a6. Play game "Grab-Bag Matching". Each pair of children is given a bag of Minnebars out of which each draws one bar. The child with the longer reference object collects bars that are longer than his reference object and the other child collects bars shorter than his reference object. The child with the most bars, when all are gone, wins.
	a7. Each group is given ten strips of paper which they are to sort into sub-sets one of which contains objects shorter than the reference object, one of which contains objects longer than the reference object and one of objects about the same length as the reference object. This may also be

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	done using a child as the reference object and the other children as the objects to be placed in subsets.
	a8. Make up riddles using the property of length as one of the identifying characteristics.
b. To realize that lengths of objects do not change even though their location or orientation may change.	b1. Place two strips of the same length in various positions asking the children each time if they are the same length. Ask them if time will affect their length.
	b2. Introduce equality and inequality symbols using them to record information for the future.
	b3. Compare the length of a child to his resting mat.
c. Three objects may be compared and placed in order of length.	c1. Place strips of paper,lengths of cord, Minnebars, and one side of triangular shapes in order according to length using the inequality symbol to record these.
d. Lengths of some objects may be variant under changing conditions.	d1. Compare the length of a piece of crepe paper and a pencil and then stretch the crepe paper and compare the length. This may also be done comparing a pencil and an icicle.
e. To understand the idea of transitivity.	e1. Arrange cords in order according to the idea of transitivity.
f. To realize that indirect comparisons between the length of objects may be made.	f1. Try to determine which of two tables in a room is longer by using a unit of measure such as a piece of string or part of a body.
	f2. Measure the circumference of some cans and ask the children to match the circumference with the can.
g. Area is the size of a region that is on a surface and is bounded by	g1. Make two closed curves with yarn. Make one circular and the other long and narrow. Discover how many children would

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a closed curve.	fit in to each curve. By one-to-one correspondence discover which closed curve holds more children.
	g2. Change the shape of one of the closed curves several times asking whether the curve is closed, whether it encloses a region, where the region is, whether the region has an area and whether it has more area than the other curve. Ask these same questions about curves drawn on the chalkboard and a sheet of paper.
h. To be able to compare the area of regions.	h1. Compare the sizes of the areas of regions of various objects by determining whether one object can be superpositioned on the another.
	h2. Binary comparisons may be used in putting objects in order. Cut out fish from a worksheet and arrange them in order of size. Flannel pieces may also be arranged on the flannel board according to size.
	h3. Play an area-ordering game in which a reference object is placed in a middle square of a row of squares. Each child draws and places his square on the proper side of the reference point.
i. To realize that regardless of when or where comparisons are made the areas of two regions will not change.	i1. Have children move around the room with sheets of paper and determine whether the comparison will be different in different places.
	i2. The areas of region of a piece of paper will be the same even if a piece of paper is cut up, folded, put back together, or unfolded.
	i3. The stretching of some object such as a piece of crepe paper will change its area of region.
j. To discover and use a test to compare the area of dissimilarly shaped regions.	j1. Compare the areas of regions of three objects. One of the objects may have to be cut and the pieces rearranged. Dissimilar regions which might be compared include odd-shaped objects, triangles, a circular and rectangular region, a crescent and a circle,

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	a star and a square, or two letters of the alphabet.
	j2. Encourage the children to discover a way of making comparisons when it can not be done by a superposition test.
	j3. Compare areas of regions of a three--dimensional object such as a cylinder by cutting it so it lies flat. The sides of a block could be traced on a sheet and compared.
k. Volume is the measure of a spatial region enclosed by a simple closed surface.	k1. Read the story, Pete's Popcorn Problem and encourage the children to discover which of two containers will hold the most popcorn.
l. The property of volume may be compared by observation, fitting one object entirely inside another, by filling one object and then pouring the content into the other object and by comparing the amounts of liquid displaced.	l1. Fit Minnecubes inside one another.
	l2. Play "Charlie Choo" arranging Minnecubes of various sizes adjacent to the reference object.
	l3. Place lumps of clay in water and observe the water level rise. Vary the shapes of the clay and repeat the experiment. Mark the levels of water.
	l4. Try placing three balls of clay in the water marking the level each time. Have each ball of clay made into a figure and determine whether the volume of the clay has changed.
	l5. Place water dyed with food coloring in containers to discover which one of two containers has the most volume.
m. To realize how events are arranged in their time order and to learn to use correctly the words "before" and "after" to denote time relationships.	m1. Arrange pictures showing activities in a chronological order.

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SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
n. The word "duration" may refer to a period of time.	n1. Play the game "Statues."The object of the game is for a person to stay a statue as long as possible.
	n2. Ask the children questions about durations of times in their lives.
	n3. Plant seeds at different times. These will be used to illustrate long durations of time that end together.
	n4. Compare events starting together and having short durations. Drop two pieces of paper to the floor, one of which has been folded into an origami design and the other a glider. Ask someone to change one piece so it will take longer to fall.
	n5. Clap in rhythm and while doing this drop a penny to the floor. Determine when the penny fell in relation to the claps.
	n6. Compare the duration of events that start together by comparing which of two sugar cubes dissolves faster: one that has been stirred or not stirred. A Fizzie and a sugar lump can also be compared, the length of time it takes to get through a maze can also be used, the time two windup toys run, and the length of time you can hear a note on the piano.
	n7. Compare the durations of two events that did not have a common beginning by diagramming the situation on the chalkboard, or by singing with a record and asking whether one's singing or the record was of longer duration.
	n8. Infer comparisons in the context of time durations of three events: A took longer than B, B took longer than C, so A took longer than C.

MINNEMAST UNIT 6

NUMERATION

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. One-to-one correspondence may be used to determine which of two sets has the greater number of members.	a1. Use one-to-one correspondence for ordering sets from the one containing the least members to the one containing the most members. The sets should contain two, four, and eight members. Members should be added to Set B to make a new set, Set D, which would make it equivalent to Set C. This activity may be done with children, blocks, counters, or toy animals. Children may wish to work with four or five sets.
b. Equivalent sets may be constructed and used as reference sets in the comparison of the number of members in other sets.	b1. Read the story Ugboo's Big Problem which introduces the idea of constructing a set of objects that is equivalent in number to an original set of objects and uses a reference set in comparing the number of members in two sets.
	b2. Pick children to be sheep and match them to a set of stones.
	b3. Play "Ugboo Game" in which a child chooses 15 sheep by matching them to stones. Ugboo leads sheep to another part of the room and determines whether he has the same number of sheep. Nip, Ugboo's brother, chooses a set of sheep and the size of his set is compared to Ugboo's. Some children may wish to hide so the set of stones is not equivalent to the set of sheep.
	b4. The flannel board may also be used in setting up sets of sheep and stones. Substitute a smaller sheep for one sheep. Determine whether it is still the same set. Can the set still be represented by the same number of stones?
	b5. Use situations involving parts of the body in relation to numbers and pairing.
	b6. Make a reference for objects on a flannel

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	board to make sure all sheep are still there at a future time.
c. Bars of the same length contain the same number of unit-lengths.	c1. Match a small bar to each large Minnebar. Discover how many one-unit bar sections there are on a five-unit bar. Make one-to-one comparisons with two bars of equivalent lengths. Match small bars with a large bar. Compare the sets of small bars and compare the large bars. This may also be repeated with two and three bars of different lengths.
d. To develop the thought processes used in numeration, addition, and subtraction.	d1. Children match two bars the teacher is holding and place them together and then find one bar as long as the two together. d2. One bar may be matched with several shorter bars. d3. Take two bars of different lengths and have a child find a bar that when combined with the shorter bar will match the longer bar. d4. Discover that a one-unit Minnebar is the only single kind of bar that can be used to match every Minnebar, and that longer bars can be matched with several combinations of shorter bars.
e. Tallies may be used as a reference set. Tallying is the setting up of a one-to-one correspondence between each member of a set and a reference mark.	e1. Read the story Tal's Aching Back which introduces the idea of using tally marks for pairing in one-to-one correspondence. Children may dramatize the story after it has been read. e2. Compare the numbers of members in sets of blocks and of those wearing a certain type of clothing. Tally marks may be made for each time the teachers says "beep". Tallying may also be used to record the number of children absent, the number of times a repeated observable event occurs during the day or a score in a bean bag game.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
f. To match number words in the counting sequence with the members of the set being counted.	f1. The idea of counting and the use of number words is introduced by reading the story Nat's Numbers.
	f2. Make up cards with sets of objects on them. Children hold up the number of fingers that show how many objects are on the card and say the number word. Fingers may also be held up while saying counting rhymes.
	f3. Ask a child to count the counters in a set. Provide a set of equal number. Have the two sets matched by one-to-one correspondence.
	f4. A child counts only the counters of a certain color.
	f5. Play "The Kitty Game" in which the kittens hide and the mother counts them as she finds them.
	f6. Words or sounds may also be counted.
	f7. Objects may be placed on the flannel board and counted. Even though their order may be rearranged the number will not be changed.
	f8. Subsets may be formed and counted.
	f9. Children may give each other and take counters from others, determining before and after the number they had.
g. To match the Minnebars emphasizing the number of units in the bars.	g1. Match particular bars using units of a given number.
h. Printed numerals may be used to represent a number of objects.	h1. Teachers display numeral cards while children select matching numeral cards. Say the number word and hold up the right number of fingers.
	h2. Cards may be made on which a numeral is written on the left side and the corresponding set drawn on the right side.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	h3. Make "Puzzle Cards" on which the numeral is matched with the corresponding set.
	h4. Distribute sets of numeral cards to each child. Each child holds up his card as his number is held up.
	h5. Make up two sets of containers labeled from 1 to 10. One set has an appropriate number of containers set inside. Then, children can fill the other containers using the first set as the reference set.
	h6. Play the game "Scramble" in which eleven children holding numeral cards try to arrange them in the right order.
	h7. Prepare cards with a numeral on one side and a set of the appropriate number on the other side. Ask a child how many are in the set shown. Then ask the child to select a picture of a set having one more or one less member. Continue until the complete sequence is developed. Turn cards over so numerals show.
	h8. Give the banker a certain number of objects. Other children give and get objects to the banker each time, naming how many they have before and after, and showing the numeral cards.
	h9. Children put out counters showing how many they have of various body parts and the numeral cards.
	h10. Have children make up story problems for the other children to solve.
	h11. Place numeral cards on the chalk tray. One card is removed and a child tries to identify it.
	h12. Count objects by placing a numeral card next to them as they are counted.

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	h13. Play "Last Child" in which two children both try to take the last child.
i. To understand the number relations of coins.	i1. Identify and name various coins.
	i2. Determine the value of each coin.
	i3. The story The Lemonade Stand will reinforce and review the children's understanding of pennies, nickels and dimes.
j. To learn how to write numerals.	j1. Trace numerals made with sandpaper or crayon.
	j2. Trace numerals on worksheets and the number of objects needed to represent them.
	j3. Practice printing numerals.
	j4. Fill in blanks with missing numerals.
	j5. Make number books in which they write one on the first page and draw a picture of one object. Repeat with each of the other numerals.

MINNEMAST UNIT 7

INTRODUCING SYMMETRY

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. A shape is said to have rotational symmetry when the object is symmetric with respect to rotation about an axis perpendicular to the shape at the center.	a1. Mark two triangular blocks with tape to show the upper face of each block. Place one block on top of the other so the taped corners match. Hold the bottom block and turn the top block until the two blocks again fit. Turn until the taped corners are in the same corner. Explain that when this can be done an object has rotational symmetry. Try this with other pairs of blocks of various shapes.
	a2. Place a blue star on top of a yellow star on an overhead projector. Turn the top star noticing the rotational symmetry.
	a3. Give each child pairs of six-pointed stars and the letter "S". Determine whether these objects have rotational symmetry.
	a4. Classify objects as to whether they do or do not have rotational symmetry.
	a5. Art activities may include cutting designs from a paper folded in eighths, making triangle flowers, pinwheels, loop-de-doos, or paper or yarn mosaics.
b. A repeating pattern is any pattern which can be made by repeating a part of the pattern at equal intervals along a straight line.	b1. Demonstrate a repeating pattern on the overhead projector with a paper doll and a chain of paper dolls. Move the single paper doll over the chain of paper dolls. The single doll illustrates the repeating pattern.
	b2. The teacher starts a pattern on the chalk board and asks a child to keep the pattern repeating. Have children make patterns from various types of objects. Change a pattern by substituting one of the objects in a pattern with another.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	b3. Classify objects as to whether they do or do not have repeating patterns.
	b4. Art activities might include making paper chains with repeating color patterns, block printing, glued-object patterns, and paper loops pasted in rows.
c. A pattern that is unchanged by a reflection is bilaterally symmetric.	c1. Show a picture of a cat's face and determine by examining and comparing each part of it whether it is bilaterally symmetric. Cut the pictures in half. Discover that if the right sides are held together that the positions of the parts are reversed.
	c2. Looking at one's hands in front of and then holding one's palms together is an example of bilateral symmetry.
	c3. Use the overhead projector and transparencies of a butterfly to show that a butterfly is bilaterally symmetric. Children will also discover that their star used earlier was bilaterally symmetric. Folded objects that fit together are bilaterally symmetric.
	c4. Use the mirror test to determine whether objects have bilateral symmetry. Provide worksheets and mirrors for the children.
	c5. Make bilaterally symmetric patterns on the flannel board. Patterns may be changed by following definite rules.
	c6. Children make bilaterally symmetric designs by completing designs, one-half of which are done.
	c7. Art activities might include making paint-- and-fold designs, punching hole designs, rubbings, abstract designs, egg-carton animals, and construction-paper figures.
d. Symmetry is present in sound and music.	d1. Recognition of rhythmic patterns may be increased by such activities as playing "Choo-choo," clapping and stamping, and rhythm bands.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	d2. Children may be shown the music of rounds.
	d3. Rhythm, rhyme, and repetition of words, sounds and images are all present in poetry. Children may count the stressed syllables.

MINNEMAST UNIT

LIVING THINGS IN FIELD AND CLASSROOM

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. Some plants grow from cuttings including geraniums, coleus, fibrous-rooted begonias, and impatiens.	al. Start cuttings of geraniums, coleus, fibrous-rooted begonias and impatiens, and watch them grow.
b. Some plants that grow from large seeds include beans, corn grains, and pumpkin seeds, and some that grow from small seeds are radishes and grass.	bl. These large seeds including beans, corn grains, and pumpkins are good for demonstrating seed structure and embryo plant parts and for experiments with seedlings. Small seeds are good for germination experiments and demonstrating the effects of light and temperature.
c. Some plants grow from bulbs including paper--white narcissus, hyacinth, and amaryllis.	cl. Grow paper-white narcissus, hyacinth and amaryllis from bulbs.
d. Plants have different parts.	dl. Examine vegetables and fruits from the grocery store. Take them apart to look at the various parts they contain.
e. Plants need moisture, light, and the right temperature in order to grow.	el. Provide classroom plants with moisture, light and the temperature and call the attention of the children to the fact that you are doing so.
f. There are different amounts of moisture, light, and heat in various places.	fl. Set up woodland, desert and bog terrariums.
g. Plants and animals provide for the needs of each other in an aquarium.	gl. Set up an aquarium with either tropical or natural pond fish and observe the activity that takes place in it.
h. All living animals possess certain characteristics and go through certain life cycles.	hl. Place animals such as parmecium, planaria, snails, mealworms, crickets, grasshoppers, scuds, guppies, toads, salamanders, rats, or gerbils in the classroom so that the children

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	may observe them. h2. Encourage the children to bring animals or parts of animals into the classroom. Ask the children where they found the animal, what it was doing, whether there were other animals there like it, how they knew that the animal was alive, what the name of the animal is and whether there is anything else that they would like to discover about the animal. If a child has brought in part of an animal, ask him what the part is and what its function is. If the animal is a pet, encourage the owner to tell its name, age, eating habits, needs for care, and uses. The charts on pages 46-51 in Living Things in Field and Classroom will be helpful in identifying animals brought into the classroom.
i. Plants have certain characteristics that can be used to aid in their identification.	i1. Ask the children where the plant was found and the type of place that it was, whether there were other types of plants like it there, and what type of plant the children think it is. If part of a plant, ask the children what the function of that part is. Ask the children how they can find out more about the plant. Charts on pages 53-56 in Living Things in Field and Classroom will be helpful in observing plant specimens.
j. Each type of rock has unique characteristics. Smooth and rounded rocks have probably been moved by water, wind, or ice. Rocks composed of sand grains may have once been part of a beach. Layered rocks that look like hardened mud or clay probably come from the bottom of a lake. Rocks that are composed of smooth and shiny plates probably were formed by pressures within the earth. Rocks that look like shells, leaves, or animals may be fossils.	j1. Encourage the children to bring in specimens of rocks or fossils telling where they found the rock, what they think is interesting about it, and what they think it looks like. j2. Encourage the children to experiment with the rocks feeling, smelling, and tasting them. Let them speculate as to why rocks may be a certain size and texture. j3. The children should label rocks as well as other items of nature that they bring in with their source, descriptions of the objects, and the name of the person that found it.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

SUN - LIGHTS AND SHADOWS

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a To discover the kinds of shadows that various objects make.	a1. Draw and cut various shapes and hold them up so they make a shadow.
	a2. Examine various objects to determine what shapes their shadows make.
b. To realize that one object's shadow may have different shapes when it is held in different positions in relation to the sun.	b1. Hold an umbrella in various ways to determine which is the biggest, roundest, smallest, and flattest umbrella shadow.
c. To realize that a shadow's shape may be recorded with chalk.	c1. Have children draw the outline of other children's shadows.
	c2. Children draw various shadow shapes on the ground and see if other children can assume them.
d. To realize that shadows can be cast on various objects.	d1. Make shadows on various objects such as paper or one's hand.
e. To realize that ones shadow does not show on a larger shadow or that there are shadows at some times but not at others.	e1. Have the children stand in the shadow of a building.
	e2. Discuss why one can not see shadows in the dark.
f. To be aware that one can't touch another person's shadow and to discover other things one can do with one's shadow.	f1. Play "Shadow Tag."
	f2. Read *The Shadow Book* by Beatrice S. De-Regneirs and Isabel Gordon.
g. To estimate where one must place one's self to make a shadow on a certain spot.	g1. Place an "x" on the sidewalk and see if a child can keep the shadow of his finger on the spot.
	g2. Encircle a certain object such as a pebble on

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	the ground with a circle made with one's fingers.
	g3. Do things with shadows such as trying to touch another person's shadow with your fingers or toes.
h. To be aware that the closer an object is to the ground the more crisp and dark its shadow will be.	h1. Hold objects such as one's hand close to the ground. Notice how its shadow becomes less clear as the object is moved away from the ground.
i. To realize that various objects can be used to make shapes.	i1. Put on a shadow play.
j. To be aware that a mirror provides another way of seeing oneself.	j1. Provide the children with "ferrotype tin" mirrors so that they may experiment with them.
k. To discover that there are natural mirrors such as puddles, windows, and ponds.	k1. Examine puddles, windows, and ponds to discover how one looks in them.
l. To realize that there is a difference between the images which a shadow makes and a photograph makes.	l1. Examine photographs and shadows of a person to discover how they are alike and different. l2. Make silhouettes and compare to photographs.
m. To discover how sunlight can be reflected.	m1. Use a mirror to reflect the sunlight onto various objects both near and far away.
n. To find out what the shape of the light is that is reflected from a mirror and learn if it is always the same.	n1. Shine mirrors of various shapes on objects to learn if the shape is always the same.
o. To find out that a shadow is all over not just on the ground where its shape can be seen.	o1. Stand in the shadow of a tree or a building to see that oneself is also in the shadow.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
p. To discover whether one can shine a light on a particular spot.	p1. Draw a curving line on the blackboard and trace its path with the flashlight beam.
q. To see the relationship between the locating and position of a shadow and the position of the sun and to realize that changes in a shadow's position during the day provides a kind of clock.	q1. Place an "x" of tape on a window and record where its shape falls on the wall at various times of the day. q2. Outline a shadow with chalk and determine whether it remains stationary. Decide whether that shadow will ever be the same again.
r. To realize that some objects may not make shadows that are visible.	r1. Classify various objects to determine whether they make a visible shadow.

E.S.S. UNIT

ANIMALS - EGGS AND TADPOLES

KINDERGARTEN

CONCEPTS	ACTIVITIES AND RESOURCES
a. To observe how frog eggs develop and grow into tadpoles. This takes place in three to seven days.	a1. Gather frog eggs from a pond or purchase them from a supplier and place them in a container of pond water in the classroom. Have the children examine them and speculate as to what they are.
	a2. Have the children predict what will happen to the eggs. Verify what they are observing by what happens to the eggs. A magnifying glass may be used to observe the eggs.
	a3. Record each day what happens to the eggs by drawing what they look like.
	a4. View E.S.S. Film Loops which show the development of frog eggs from laying to hatching.
b. To learn whether the temperature of the water affects the amount of time it takes the eggs to hatch.	b1. Place containers of tadpoles in various locations in the classroom. Observe whether the temperature of the water affects the time the eggs will hatch.
c. To discover what tadpoles eat.	c1. Observe how the tadpoles eat the green scum (Algae) growing on the side of the aquarium. Discuss where tadpoles would get food in a pond. What body characteristics help them get this food? How does the shape of their mouth affect their feeding? Does the presence of pond plants affect the growth of the tadpoles? Do they prefer certain types of algae?
d. Are the tadpoles' lives and growth affected by crowding?	d1. Place tadpoles in two containers, one crowded and one uncrowded. Observe and compare their size and behavior.
e. To see how they swim.	e1. Observe the tadpoles swimming. What parts of their bodies help them move? In what directions can they move? Compare the way a child swims to the way a tadpole swims.

CONCEPTS	ACTIVITIES AND RESOURCES
f. To observe the tadpoles changing into frogs. About the sixth or eighth week after hatching, two legs will appear at the base of the tail and after a few more weeks webbed toes will develop. The front legs will appear, the whole shape of the tadpole will begin to change and the tadpole will become a frog.	f1. Observe the growth of the tadpoles, checking them every week to determine whether the hind legs have developed. Give the tadpoles something to crawl upon when their hind legs look frog-like and cover the container.
g. To observe the frogs develop into adult frogs. This usually takes between one month and one year.	g1. Adult frogs need a container with some sand or soil at one end, water for swimming, and rocks both on the sand and in the water. Also, place aquarium plants in the water.

E.S.S. UNIT

ENERGY - MOBILES

KINDERGARTEN

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a A mobile is a delicately balanced construction or sculpture having movable parts that can be set in motion by air currents or mechanical propulsion.	al. Discuss what a mobile is and how it is constructed. The children should determine the shapes that they would like to design. Talk about the characteristics and details of the subjects that the children have selected.
b. To develop an understanding of some of the laws of balance.	bl. Experiment with the physical balancing involved in making a mobile.
c. To heighten an awareness of symmetry.	cl. The shapes to be suspended are cut from a material of uniform thickness and quality. Visual clues will help the child to find arrangements which hang evenly.
d. Weight affects systems which are balanced.	dl. The child will discover that the downward pull of all the weight is concentrated on the single string which supports the mobile at the top.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

ATTRIBUTE GAMES AND PROBLEMS

KINDERGARTEN

	SKILLS AND CONCEPTS		ACTIVITIES AND RESOURCES
	Attribute Games and Problems develop thinking skills in children. They provide opportunities for children to deal with problems involving classification and the relationship between classes. Experiences with such problems can help provide the familiarity and the skill necessary for solving problems in science, social studies, mathematics, or whatever classification and dealing with the relations between classes called for.		
a.	To separate and analyze the components of objects dealing with them one at a time.	a1.	To ask for a particular object by its size, color, and shape.
		a2.	To select a People Piece having a particular attribute.
b.	To predict on the basis of visible material, what other objects will be included in a particular set.	b1.	Look at a group of Attribute Blocks or People Pieces and determine which objects or pictures are missing.
		b2.	Have a child name all the Attribute Blocks or People Pieces in a set without looking at them.
c.	To view one object as part of a whole.	c1.	Discover what types of constructions can be made with Attribute Blocks.
d.	To use sequential analysis in classifying objects.	d1.	Classify People Pieces or Attribute Blocks by one or more attributes and have the children identify what these attributes are.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

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a. To separate and analyze the components of objects dealing with them one at a time.	a1. To ask for a particular object by its size, color, and shape. a2. To select a People Piece having a particular attribute.
b. To predict on the basis of visible material, what other objects will be included in a particular set.	b1. Look at a group of Attribute Blocks or People Pieces and determine which objects or pictures are missing. b2. Have a child name all the Attribute Blocks or People Pieces in a set without looking at them.
c. To view one object as part of a whole.	c1. Discover what types of constructions can be made with Attribute Blocks.
d. To use sequential analysis in classifying objects.	d1. Classify People Pieces or Attribute Blocks by one or more attributes and have the children identify what these attributes are.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
e. To experiment with symbol systems, and systems of representation and devise these systems for oneself.	e1. Build with Attribute Blocks using them to represent such things as people, trees, etc.
f. To classify by attributes and to develop and use efficient classification systems.	f1. Have the children pick out all the blocks or people pieces that have a particular attribute.
	f2. Ask children to divide the blocks among themselves in an orderly manner.
	f3. Children play a "Three Questions" game. Provide the children with step-by-step information that will lead to selection of a particular piece from a group. Include negative statements when giving information.
	f4. A child asks questions about a particular subset of Attribute Blocks or People Pieces to determine which object a person has in mind.
	f5. Start off playing the above without having a specific object in mind. Allow the values of each attribute to be determined by the child's questions by saying "No" to each of his first three questions.
g. To learn the meaning of the word, "attribute."	g1. Classify a group of Attribute Blocks or People Pieces according to an attribute such as shape.
h. To understand the meaning of the word, "value."	h1. The four shapes that you would find after classifying the blocks according to shape: triangle, diamond, square, and circle would be called the values of the attribute shapes. People Pieces could also be classified according to values.
i. To grasp the meaning of the words, "set" and "subset."	i1. Work with sets and subsets of Attribute Blocks or People Pieces asking the children to pick out subsets.
j. To develop a greater awareness of the abstract nature	j1. Count the numbers of objects in sets and subsets.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
of number.	
k. To understand the meaning of the word, "intersection."	k1. An example would be to find that an intersection of the subset of diamonds and the subset of yellows contains two blocks, the yellow diamonds.
l. To understand the meaning of the word, "union."	l1. An example would be the putting together of the subset of diamonds and the subset of yellows. The "union" would include all eight diamonds and all eight yellow pieces.
m. To understand the idea of representation by mapping.	m1. Have one child make a picture with his Attribute Blocks or Color Cubes and encourage another child to copy the pattern.
	m2. Reproduce another child's pattern with blocks of another color.
	m3. Reproduce a child's pattern with blocks of a different size.
	m4. Reproduce a picture or pattern with Attribute Blocks of a different shape.
	m5. Copy a picture with attribute stickers or copy a picture made with attribute stickers with blocks.
n. To understand matrices as a method of classification.	n1. Set up a matrix with People Pieces or Attribute Blocks and determine what is missing.
	n2. Remove a block from a matrix and determine which block is missing.
	n3. Develop a double matrix including both large and small blocks.
	n4. Remove a stack or stacks of two blocks and see if the children can determine what is missing.
o. To discover how to record pairs and the numbers of differences between the	o1. Use stickers to keep track of pairs formed.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
objects in the pair.	
p. To determine the shape of an object using the sense of touch.	p1. Place an object inside a piece of cloth to see whether a child can identify the object by feeling its shape.
q. To discover a rule by testing specific instances to see whether they conform to it and to apply the type of reasoning done about class relationships.	q1. Invent a rule as to what type of pieces go into a box and let another child discover the rule by asking what pieces may be placed in the box.
r. To focus on classes without losing one's awareness of the attributes of specific pieces.	r1. Place two loops on a table, putting labels on each as to what attribute each section's Attribute Blocks or People Pieces should contain.
	r2. Overlap the labeled loops and discover some objects that belong in the overlapped parts of the loops.
	r3. Add additional loops so that the Attribute Blocks or People Pieces may be classed by additional attributes.
	r4. Place objects in loops and discover whether one's partner can decide what the label should be for each loop.
s. To be able to arrange things in an orderly way.	s1. Arrange Attribute Blocks in order according to size.
	s2. Arrange People Pieces in some type of sequence.
t. To discover how many subsets can be formed from a set containing a certain number of elements.	t1. Use different numbers of loops and discover how many subsets can be made with the Color Cubes.
u. To analyze and predict.	u1. Play "Three-in-a-Row" with Color Cubes. Two or more people each choose a color of Color Cubes. Each person tries to be first to get his three Color Cubes in a horizontal, vertical, or diagonal row.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
v. To discover the pattern used in placing objects.	v1. Place four loops in a pattern and place Color Cubes in the proper parts of the loop.
w. To see the pattern in a group of objects.	w1. Remove a cube or cubes from a pattern and have another child determine what is missing.
	w2. Discover how many cubes can be removed without destroying a pattern.
	w3. Remove a group of cubes, reverse them, and return them. Child determines what has been removed and replaced.
x. To be aware of the logical relationships between classes of objects.	x1. Make Latin Squares with Color Cubes. A Latin Square is an arrangement of elements, (numbers, letters, colors, etc.) such that no two elements are repeated in any row or column of a square. In making a Latin Square from Color Cubes, there would be only one cube of each color in each row and only one of each color in each column.
	x2. Make other Latin Squares with different arrangements of squares.
	x3. Move rows of Color Cubes to different locations within the Latin Square and notice what happens to the diagonals.

THE UNIVERSE, THE SUN AND THE MOON

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
a. The universe is composed of the earth, the sun, the moon, and everything in the sky.	a1. Read The Sun, the Moon and the Stars. a2. Read What is a Solar System?
b. Stars begin as dust clouds called nebulae composed of particles which have been pulled together into pockets by gravitational pull. Thermonuclear reactions produce radiant energy which causes the stars to stay incandescent and hot.	b1. Have the children make pictures showing the patterns of familiar constellations which they might find in the sky. b2. Have the children map out various constellations inside an umbrella. b3. Read The Big Dipper by Franklyn M. Branley. b4. Use David C. Cook Teaching Picture, "Moon and Stars" and Resource Sheet No. 6. b5. Show filmstrip, "Finding Out About the Sky".
c. The rotating sun which is located in space is a gaseous mass and has sunspots which are huge bubbles of hot gases. It appears to be round in shape and is a star.	c1. Show filmstrip, "The Sun," EBF. c2. Read The Sun: Our Nearest Star, by Franklyn M. Branley. c3. Use David C. Cook Teaching Picture, "The Sun" and Resource Sheet No. 10.
d. The sun provides energy for the earth. It makes radiant heat and light from the energy of nuclear reactions. The hydrogen of the sun is converted to helium with the release of much energy.	d1. Show film, "The Big Sun and Our Earth." d2. Read Thank You, Mr. Sun by Hyman Rucklis. d3. Discuss what it would be like if there were no sun.
e. The sun sends out light energy which travels in waves. Each color is a different wave length. Sunlight is made up of	e1. Use a prism to separate the various wave lengths of color in light. e2. Discuss natural prisms such as raindrops and observe rainbows in the sky.

CONCEPTS	ACTIVITIES AND RESOURCES
a mixture of light of different wave lenghts. Sunlight, reaching the earth, strikes various objects. The light is reflected by some objects and absorbed by others. One sees the object as the color of the reflected light.	
f. The sun is always shining. It lights up the day side of the earth while the earth's shadow causes darkness at night. The rotation of the earth causes night and day. Time is measured by the rotation of the earth and a day is about twenty-four hours in length.	f1. Place a lamp in the center of a circle. Have a child pull a wagon in which a globe has been placed around the circle. One child turns the earth while it is being pulled in the wagon.
	f2. Point out a location on the globe where it would be day and have another child identify a place where it would be night.
	f3. Read What Makes Day and Night by Franklyn M. Branley.
	f4. Read Sun Up by Alvin Tresselt.
	f5. Read Wake Up, Farm by Alvin Tresselt.
	f6. Read The Day We Saw the Sun Come Up by Alice Goudey.
g. North is toward the North Pole. When facing north, east is on your right, west is on your left and south is behind you.	g1. Label the walls of the classroom with North, South, East, and West.
	g2. Play the game in which you tell the children to face various directions.
	g3. Read North, South, East, and West by Franklyn M. Branley.
h. Shadows are caused by any object that comes between the sun and earth. Changes in position of this object relative to the sun cause changes in the length of the shadows of the object.	h1. Read The Shadow Book by Beatrice S. DeRegniers and Isabel Gardner.
	h2. David C. Cook Teaching Picture, "Sunlight and Shadow" and Resource Sheet No. 8.
	h3. Drive a post into the ground somewhere on the playground. Measure the length and direction

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
	of the shadow of the stick at various times during the day.
	h4. Read What Makes a Shadow by Clyde Bulla.
i. The sun is behind the clouds on cloudy days. The clouds absorb and reflect most of the sunlight before it reaches the earth.	i1. Use a piece of cotton to represent clouds and hold it between a flashlight and a globe so that the children may see how the earth is shaded by the clouds.
	i2. Observe the sky on cloudy days and note that the temperature is usually lower than it is on days when it is not cloudy.
j. Planets orbit the sun.	j1. Have children represent the sun and the planets. Draw a path for each to orbit the sun.
k. The moon, a natural satellite of the earth, orbits around the earth as it revolves around the sun. Round in shape, it is located about 240,000 miles from earth. The moon reflects light from the sun. Stars are always shining in the black airless sky of the moon.	k1. Have the children make a movie about a trip to the moon. k2. Have the children observe the moon and describe its appearance. k3. Compare the moon's shape to other objects.
l. The moon has no life on it. Dust covers the waterless and barren broad, flat crater and mountain covered plains of the moon.	l1. Have the children list all the things that they would need to take along when they went on a trip to the moon. l2. Have the children make a chart comparing the characteristics of the earth and the moon and list all the things that they know about the earth and the moon. l3. Read What the Moon is Like by Franklyn M. Branley.
m. The moon passes through four phases including new moon, crescent, gibbous, and full moon in a period of about 29 1/2 days.	m1. Encourage the children to observe the moon in its various phases and note how it changes. Call their attention to the charts shown on some calendars which indicate when the moon enters a certain phase.

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
	m2. Do the experiment described in Concepts in Science 2, Harcourt, Brace, and World, p.133. This experiment illustrates how the appearance seems to change.
	m3. Read The Moon Seems to Change by Franklyn M. Branley.
	m4. Have one person hold a ball and another person shine a light on it. The person who is holding the ball turns around slowly and discovers when the lighted part seems largest.

WATER, WEATHER, AND AIR

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
a. There are many types of bodies of water including streams, lakes, rivers, bays, ponds, oceans, and swamps.	a1. Have the children list various types of bodies of water that they have seen.
	a2. Visit various bodies of water within the vicinity of the school and classify them according to their type.
	a3. Read Where the Brook Begins by Margaret Bartlett.
	a4. Read The Bottom of the Sea by Augusta Goldin.
b. Water wears down, breaks off, dissolves, and changes much of the earth's surface.	b1. Observe the ground and street after a rain storm and note how water has carried the particles along.
	b2. Pour water on the ground with a hose and notice how it moves the soil and washes it away.
	b3. Read The Clean Brook by Margaret Bartlett.
c. Water can be in a liquid, solid, or gas state. The form is determined by the state of the molecules. Water is made up of molecules, each of which consists of two atoms of hydrogen and one of oxygen. Evaporation occurs when water molecules escape into the air and become invisible. Condensation occurs when warm, moist air is cooled.	c1. Wet a spot on the blackboard and watch the water evaporate.
	c2. Fill two containers with water marking water levels with rubber bands. Allow the containers to stand for a few days leaving one uncovered. Observe what happens to the water in the uncovered container.
	c3. Place a glass jar containing water outside on a cold day and another jar filled with water inside the classroom. Note the water drops that appear on the outside of the jar that was outside when it is brought into the classroom.
	c4. Read Icebergs by Roma Gans.
	c5. Show film, "Water in the Air."

CONCEPTS	ACTIVITIES AND RESOURCES
d. Water contains dissolved air. Cold water holds more air than warm water. As cold air becomes warm, the dissolved air it contains begins to form bubbles. Air bubbles rise to the surface and break when water is heated over a flame. Bubbles show that there is air in the water.	d1. Place a thin glass bottle with its open end under water in sunshine. As the air in the bottle is heated by the sun, bubbles will show that air is escaping. Place the bottle in a cool place. The air will contract and water will enter the bottle. d2. Place a bottle of pop in the freezer, marking the level of the pop in the bottle. Note what happens to the level of the liquid in the bottle.
e. Rain, snow,hail, and sleet are all forms of water known as precipitation which falls from clouds. Rain falls to earth because water droplets have become too heavy to float within a cloud. Sleet is rain that freezes and solidifies on its way to the ground. Snow forms when water vapor changes directly into a solid without going through a liquid state. Hail is an accumulation of snow and solidified raindrops.	e1. Show film, "Water, Water, Everywhere." e2. Read book, Rain and Hail by Roma Gans. e3. Show film, "Rain." e4. Show film, "One Rainy Day: Background for Reading and Expression." e5. Use David C. Cook Teaching Picture, "Snow," and Resource Sheet No. 7. e6. Read Snow is Falling by Franklyn M. Branley. e7. Read Katy and the Big Snow by Virginia Burton.
f. Each snowflake is different in appearance from every other snowflake, but each has six sides.	f1. Collect falling snowflakes on a chilled piece of black cloth and examine them with a magnifying glass. f2. Have the children make snowflakes from paper.
g. Clouds consist of tiny drops of water that take shape around microscopic specks of dust as the vapor condenses. Millions of cloud droplets group together to form one big	g1. Show film, "Weather for Beginners." g2. Read Hide and Seek Fog by Alvin Tresselt.

CONCEPTS	ACTIVITIES AND RESOURCES
cloud. Fog is a cloud that touches the ground. Warm, moist air blows across a cool stretch of ground. The cold surface of the earth carries water vapor into the warm air to condense as fog.	
h. Lightning occurs when a large, static charge of electricity is discharged. According to Science 2, published by Silver Burdett p. 94, "It is believed that the upper part of the clouds becomes positively charged, while the lower part becomes negatively charged. The ground beneath the clouds also becomes positively charged. When the difference in charge is great enough, a giant spark moves downward. The gas particles along the path become charged, and after the giant spark reaches the ground, another charge moves rapidly up the path. This upward surge is responsible for the flash of light associated with lightning. As many as thirty charges move up and down the same charged path in one lightning discharge. The positive charge of the ground tends to follow the cloud. Objects that rise from the ground, which also become charged, are more likely to be struck by lightning."	h1. Discuss preventive or safety measures which should be taken to avoid being harmed by lightning. These measures include not swimming, not standing under lone trees, or other structures, and remaining close to the ground. h2. Read Flash, Crash, Rumble, and Roll by Franklyn M. Branley.

CONCEPTS		ACTIVITIES AND RESOURCES	
i.	A rainbow appears in the sky when the sun is shining and it is raining or misting. The sunlight shines through the raindrops which separate the colors in the rainbow.	i1.	Observe rainbows in the sky.
		i2.	Look at light through a prism.
		i3.	Use David C. Cook Teaching Picture, "Rain," and Resource Sheet No. 3.
j.	Weather changes often and different indications of weather changes can be observed.	j1.	Keep individual or group records of the various types of weather that occur each day.
		j2.	Encourage the children to watch weather reports on television.
k.	Wind, moisture, sunshine, and temperature are all parts of the weather and affect our daily activities.	k1.	Show film, "How Weather Helps Us."
		k2.	Use A Book to Begin on Weather by Leslie Waller.
l.	A thermometer can be used to estimate temperature and to measure it exactly. The amount of heat causes the raising and lowering of the liquid. Temperatures differ according to the seasons.	l1.	Place thermometers in containers of hot and cold water and note the movement of the liquid.
		l2.	Provide experiences for the children in reading the temperatures on various thermometers.
		l3.	Decide which of two thermometers could show the temperature of a particular season.
m.	Air occupies space, has force and weight, and exerts both pressure and resistance. It expands and contracts. Air is composed of the solids, liquids, and gases that make up the atmosphere. It consists of 78% nitrogen, 21% oxygen, and 1% other gases including argon, carbon dioxide, neon, helium, methane, krypton, hydrogen, nitrous oxide and xenon. Air also	m1.	To show the effect of air pressure, place your finger on the end of a straw and place the other end in a glass in which a few drops of food coloring has been mixed with water. Water does not enter the straw because of the air pressure. Remove your finger from the straw. The straw will fill with water to the level of the water in the glass. Place your finger over the top of the straw before removing it from the water. The water will remain in the straw until your finger is removed.
		m2.	Blow bubbles with a mixture of soap and water.
		m3.	Show film, "Air and What It Does."

CONCEPTS	ACTIVITIES AND RESOURCES
	m4. Read Air is All Around You by Franklyn M. Branley.
	m5. Use David C. Cook Teaching Picture, "Air," and Resource Sheet No. 11.
	m6. Use poem, "Air" from Grade Teacher, March, 1968. Air Air is cool. Air is warm. Air is busy in a storm. Air is moving. (That's the wind) Air is still, As though it's pinned. Air is heavy, thick and gray, Especially on a foggy day. I don't know ALL about the air, But I know this . . . It's always there.
n. The earth's atmosphere is a blanket of gases that surrounds the earth. Air is all around us. Living things need air in order to survive.	n1. Read Air All Around by Tillie S. Pine and Joseph Levine.
	n2. Place a plant inside an airtight container and another outside the container and note what happens to the one inside.
	n3. Test different places to see if air is present by fanning your face with your hand.
	n4. Place a piece of sod in water and notice the air bubbles that rise from it.
o. Air movement is caused by changes in the temperature of the air. The force of the wind varies and the wind can be both helpful and harmful.	o1. List things that wind can move outdoors such as sailboats, leaves, flags, and windmills.
	o2. Fly a kite on the playground.
	o3. Read Follow the Wind by Alvin Tresselt.

CONCEPTS	ACTIVITIES AND RESOURCES
	o4. Have the children draw pictures showing ways in which the wind is helpful and harmful.
	o5. Show films "Blow, Wind, Blow, Introducing Air," and "Wind and What It Does."
p. Wind blows from different directions.	p1. Attach a streamer to a piece of wood and hold it up in the air to determine the direction from which the wind is blowing.
	p2. Keep a record each day in the classroom of the direction from which the wind is blowing.

E.S.S. UNIT

GROWING SEEDS

GRADE ONE

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. Define what a seed is in terms of what a seed does. Every seed has a little plant inside with food all around it. A seed is something that grows.	a1. Have the children bring in anything they think might be a seed and decide how they can tell whether an object is a seed or not.
	a2. Give the children each a packet of seeds including some objects that are not seeds.
	a3. Encourage the children to look inside the seeds.
	a4. Try to set up a criteria as to what a seed is.
b. A seed may be planted in dirt.	b1. Divide a large box of dirt into several plots and have a group of children plant seeds of a particular kind in each plot. How should each plot be labeled to show the type of seed in it?
	b2. Children may plant extra seeds in small plastic boxes.
c. The seeds are changing.	c1. Encourage the children to dig up some of the seeds they have planted. They will learn that some of the objects are larger, softer, and easier to open than before. What role has been played by soil or water?
	c2. Give each child six or eight peas or beans that have been soaked for twenty-four hours. Compare the appearance of the seeds to how they looked earlier. Are they the same size? Open the seeds and discover what is inside. Compare the soaked seeds to seeds that have been planted.
	c3. Four or five days after planting, dig up some more plants and examine them. Predict what the seed will grow into. Vary conditions such as planting a seed at the bottom of the box or on top of the soil. Discover what happens when half a seed is planted.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
d. Seeds vary in the amount of time they need to sprout.	d1. During the second and third week, summarize what has happened to the seeds. Determine whether they are the same as when they were first planted. Decide which plants come from which type of seeds. Is the seed still visible when the plant begins to grow? Do all the seeds sprout in the same amount of time?
e. Many kinds of seeds are enclosed in a pod or some other type of cover.	e1. Open pods, not the little stems by which the seeds are attached to the pod. Scars on seeds show where they were attached.
	e2. Do the children know of any seed coverings? Do they eat any? What seeds do they eat? How do peas and beans get out of the pods?
	e3. What happens to the seeds in pods if the pods are not picked? Encourage the children to look for milkweed pods and seeds, sticktights, cockleburs, acorns, sycamore balls, and locust pods in the fall. Determine where the seeds go that were in empty seed pods. Have the children found seeds clinging to things?
f. Bean plants grow and develop from bean seeds.	f1. View the film loop, "Bean Sprouts."
g. Measurements must be made comparable by starting them all from the same place.	g1. Ask the children to identify the tallest plant in the room. Determine ways in which they can actually show which is the tallest. Discover that a strip of construction paper may be used to measure the height of a plant.
	g2. Predict how tall the plant will be the next day. Measure the plant with one strip and use the second strip as a "guess strip."
	g3. Examine an ear of Indian corn and allow each child to pick off one kernel and plant it in a paper cup. Give the children strips of paper so that they may measure the growth of their plant each day. They will probably go about this in different ways. Widths of

GRADE ONE

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	fingers serve as useful measures in making comparisons.
h. Gain an understanding of the usefulness of order. Learn how the strips relate to each other.	h1. Ask the children questions about how fast the plants are growing that they will answer by looking at their strips. They may discover that an ordered arrangement may help them find the answers more quickly. Ask the children questions about the heights of their plants on various days. Determine who had the tallest plant on a particular day. Decide who had plants of the same height on a particular day. The children may also ask questions of each other.
i. Predict unknown data from known data.	i1. After the children have gained skill in finding one strip, ask then to find and compare two or more strips. Have them find two strips that show the day their plant grew most. Strips from a Friday and Monday can not be considered as strips from consecutuve days. The children may wish to make "guess strips" for Saturdays and Sundays. Children may also wish to make "guess strips" when they have been absent.
j. Create an awaremess of useful ways to arrange information such as graphs and see a graphic picture of the growth of a seedling.	j1. Make plant-growth pictures by pasting strips on a sheet of construction paper. Ask the children to answer questions requiring information from their graphs. The children may also ask each other questions. Exchange graphs and determine whether the children can read each other's graphs.
	j2. Ask questions that can only be answered if the strips are in order.
	j3. Show the children graphs which were made by the classroom teacher.
	j4. Children may wish to reconstruct their graphs.
	j5. Show children a photograph of a plant--growth graph in the film loop, "Plant Growth--Graphing."
	j6. Show the film loop, "Plant Growth--Graphing."

PLANTS

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
a. The parts of most plants include stems, roots, leaves, flowers and seeds and seed coverings. Parts of plants vary in size, shape and structure. These differences help one identify various plants.	a1. Use Instructo Flannel Board Aid "Study of Plant Growth." a2. Have pictures of plants with some parts missing. Children must match the picture of the missing part to each plant picture. a3. Point out the various parts of a plant in the classroom. a4. Draw a plant on the chalkboard and have the children label the parts. a5. Read booklet Plants published by American Book Company.
b. There are many different kinds of stems that help one tell one kind of plant from another. Stems differ in size, shape and smoothness. Different types of stems include tree trunks, vines, tough woody stems, juicy stems and juicy meaty stems.	b1. Collect samples of different kinds of stems and classify them according to type. b2. Identify the stems of various plants.
c. Stems serve as supports for other plant parts. They conduct water and minerals to leaves and conduct manufactured food from leaves downward. Food and water may be stored in stems.	c1. Place a piece of celery in some red colored water. Observe how the colored water moves up the plant stem. c2. Cut a bulb that has grown into a plant in half. Observe how the food supply inside the bulb has been depleted.
d. There are two nain types of roots. Tap roots extend downward with minor branches. This type of root is	d1. Collect samples of various types of roots. d2. Read Up Above and Down Below by Irma E. Webber.

CONCEPTS	ACTIVITIES AND RESOURCES
usually found in dry areas where roots must penetrate to a considerable depth to reach water. Fibrous root systems have branching fibrous roots without a main taproot. They usually grow where soil is moist.	d3. Compare the roots of various plants.
e. Roots absorb water and dissolve minerals which are conducted from roots to stems where they are transported to the leaves. Roots anchor growing plants to soil. Roots usually grow downward and stems upward.	e1. Dig up various types of plants and examine their root systems. e2. Cut the roots off a plant and stick the stem in the soil. Note how it easily pulls out of the ground when it does not have roots. e3. Observe a radish plant growing in a glass of water between a piece of paper towel and the glass. No matter how the container is turned, the roots will grow down and the stems will grow up. e4. Observe various plants growing in containers of water.
f. Leaves vary greatly in color, size, shape, type of margins, pattern of veins, whether they are divided into leaflets and how the leaflets are attached to the leaf stalk. Margins may be smooth, notched, saw--toothed, or ruffled. The two types of veins are parallel veins and net or branched veins.	f1. Children bring samples of leaves to school and use them to illustrate the differences. f2. Make leaf prints. f3. Make spatter prints of leaves. f4. Read Leaves by Bertha M. Parker. f5. Use Society for Visual Education Stud Print Set "Broadleaf Trees, Group 1." f6. Identify and compare the leaves of various plants. f7. Use The Doubleday First Guide to Tree to identify leaves.

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
g. Food for a plant is manufactured in the leaves of the plant.	g1. Remove all the leaves from a plant and observe what happens to it. g2. Observe how trees and leaves look in the fall when food is no longer manufactured.
h. Flowers differ in color, size and shape of petals. Flowers may have many small petals, a few large petals or none at all. Some flowers grow in clusters on a stem while others grow singly. At the center of the flower is the pistil which leads down to the immature seed at its base. Stamens, fragile filaments with bulbous tips, surround the pistil.	h1. Use Society for Visual Education Study Print Set "Spring Wild Flowers, Group 1." h2. Use Judy Company See-Quee the"Flower".
i. The pollen, powdery material from the tip of the stamen of the flower is transferred by insects, birds, the wind, water, or gravity to the tip of the pistil. The pollen grains merge with the ovules and fertilize them.	i1. Cut a flower and the upper part of the stem lengthwise. Observe and examine the developing seed at the base of the flower. i2. Show the children a large model of the cross-section of a flower and point out the path that the pollen grains would follow.
j. Seeds and seed coverings differ in size, shape, texture, and color. Different amounts of seeds are produced by various plants. Some seeds have individual coverings. Other coverings contain two seeds or more.	j1. Compare seeds as to size, shape and covering. j2. Classify seeds and seed coverings that are food as to whether they are fruits, vegetables or nuts.

CONCEPTS	ACTIVITIES AND RESOURCES
k. Seeds are scattered in different ways. They are parachutes, stick to animals' hair and peoples' clothing, are carried by animals, are wingers or spinners, shot out of their pods, or shaken out of their containers.	k1. Use Instructo Flannel Board Aid "Seeds and Their Travels."
	k2. Read Travelers All by Irma E. Webber.
	k3. Use Instructor Primary Science Concept Chart "Seeds Travel."
l. Plants reproduce by seeds. Seeds produce the kinds of plants from which they come. Seeds germinate at different rates and plants grow at different rates.	l1. Show film"Learning About Flowers."
	l2. Read Seeds and More Seeds by Millicent Selsam.
	l3. Read We Read About Seeds and How They Grow Webster Junior Science Series.
m. New plants may be grown from seeds, bulbs, or cuttings.	m1. Place a geranium cutting in a container of water and watch it grow.
	m2. Grow various types of seeds in the classroom.
	m3. Grow some Paper White Narcissus bulbs in the classroom.
	m4. Use Instructor Primary Science Concept Chart "Most Plants Grow from Seeds."
n. Plants must have the right conditions including good soil, sufficient water, suitable temperatures, and the correct amount of light in order to grow.	n1. Use Instructor Primary Science Concept Chart "Plants Need These Things to Grow."
	n2. Deprive plants of water and observe what happens to them.
	n3. Try growing one plant in dirt and another in stones and compare their growth.
	n4. Place one of two plants in a refrigerator and compare their growth.
	n5. Place one of two plants in a box and compare their growth.

CONCEPTS	ACTIVITIES AND RESOURCES
o. Plants grow in many different types of environments.	o1. Use Instructor Primary Concept Chart "Plants Grow in Many Places." o2. Show and discuss desert pictures from Arizona Highways magazines. o3. Urge the children to bring pictures of plants that do not grow in their environment.
p. Plants provide us with food, shade, fibers for cloth and paper, antibiotics for the treatment and prevention of diseases, and building materials.	p1. Show filmstrip "Plants and the Things We Use." p2. Show film "How Plants Help Us." p3. Read Pick a Raincoat, Pick a Whistle by Lillian Bason. p4. Read The True Book of Trees, by Richard Gates. p5. Use the Instructor Primary Science Concept Charts "We Eat Plants" and "We Use Plants."
q. Plants provide shelter, protection , and food for animals and materials for their homes.	q1. Show the children pictures in which animals are using plants and list different ways in which they are using them. q2. Encourage children to observe animals using plants in different ways. q3. Use Instructor Primary Science Concept Chart "Animals Use Plants."

ANIMALS

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Any living thing that is not a plant is an animal. Animals can move whereas plants are stationary. Animals find there own food while plants make their own food.	a1. Catergorize various objects as plants or animals using criteria listed in concept. a2. List the animals seen during a trip to the zoo and determine to which group each belongs.
b. Animals need protection from their enemies and from extreme weather conditions. They need a place to sleep, rest, and rear their offspring.	b1. Take apart a bird's nest. Sort and catergorize the materials that comprise the nest. These may include plant materials (leaves, twigs, bark, and grasses), fur or hair, dried mud or clay, manmade substances (string, paper, cloth). b2. Use Instructor Primary Science Concept Chart, "Animal Homes".
c. Animals obtain food by eating plants growing in their surroundings, by preying upon and eating animals that eat food or by eating both plants and animals.	c1. Show film, "Animals-Ways They Eat." c2. Use Instructor Primary Science Concept Chart, "Animal Foods."
d. Animals differ in size and each has a certain size limit. The size of an animal is determined by heredity.	d1. Compare the size of various animals. d2. Use Instructor Primary Science Concept Chart, "Animals are Many Sizes."
e. Animals differ in number, size, kind, and shape of body parts. These body parts include head and mouth, feet and legs, tail, fins, wings, and neck.	e1. Make up riddles about animals that stress difference in size and body parts. e2. Use David C. Cook Teaching Picture Set "A Trip to the Zoo," and Resource Sheet.

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
f. Animals differ in their type of body covering including feathers, shells, hair, or skin.	f1. Look at pictures of animals and determine their body covering. f2. Classify pictures of animals according to the animal's body covering. f3. List animals that have the same body coverings as a robin, frog, dog, and turtle.
g. Animals may differ in their color or markings. Patches, solid colors, stripes, and spots are called markings.	g1. Look at pictures of animals and classify them according to their type of markings. g2. Bring a pet into the classroom and note the animal's markings. g3. Show filmstrip, "Animals of the Zoo."
h. Animals may differ in the way they move. Body parts have been adapted to enable them to move in particular ways--walk, run, bound, jump, fly, swim, glide, slither, and swing. Some animals can use two or more methods of moving.	h1. Name animals seen recently and tell how they move. h2. Show children pictures of three animals that move one way and one of an animal that moves a different way. Have the children pick out the three pictures of animals that move the same way. h3. Show the following films: "Animals Move in Many Ways" "Animals - Ways They Move" h4. Read Fast is Not a Ladybug by Meriam Schlein.
i. All animals are born, eat, move, grow, and become adults. As an adult, they resemble their parents in many ways.	i1. Show film "Farm Animals." i2. Show filmstrip "Finding Out How Animals Live."
j. All birds have common physical characteristics distinguishing them from other animals. Those include feathers covering their bodies, two wings, and two legs.	j1. Use Judy Company See-Quee "Robins." j2. Show filmstrips "Birds We Know" and "Birds of Our Community." j3. Several pictures of birds are included in the sets of Teaching Pictures published

CONCEPTS	ACTIVITIES AND RESOURCES
	by David C. Cook Company.
	j4. Use Society for Visual Education Study Print Sets "Common Birds, Group 1" and "Familiar Birds, Their Young and Nests."
k. All mammals have common physical characteristics distinguishing them from other animals. These include hair on their bodies, being warm blooded, and feeding young milk from their mothers bodies. They bear their young alive.	k1. Use Society for Visual Education Study Print Sets "Wild Animals, Group 1," "Farm and Ranch Animals" and "Zoo Animals." k2. Show filmstrip,"Finding Out About Mammals."
l. All insects have common physical characteristics distinguishing them from other animals. These include six legs and two feelers or antennae. Bodies of most insects are covered with chitin a horny substance which is light and flexible, tough and waterproof.	l1. Several insect pictures are included in the sets of Teaching Pictures published by David C. Cook Company. l2. Read We Like Bugs by Gladys Conklin. l3. Use Society for Visual Education Study Print Sets, "Common Insects, Group 1" and "Moths and Butterflies, Group 1." l4. Collect insects and bring them into the classroom to observe.
m. Fish have scales, live in water and breathe by means of gills. Most fish lay eggs but some bear live young.	m1. Use David C. Cook Teaching Picture "Fish" and Resource Sheet No. 9. m2. Use Society for Visual Education Study Print Set, "Familiar Fresh-Water Fish." m3. Set up an aquarium in the classroom.
n. Amphibians lay their eggs in water. Tadpoles hatch from the eggs and lead a fishlike existence. They breathe with gills. Their body changes, they breathe through lungs and spend their adult life on land.	n1. Use David C. Cook Teaching Picture "Frogs and Toads" and Resource Sheet No. 4. n2. Read What is a Frog? by Gene Darby. n3. Use Society for Visual Education Study Print Set, "Reptiles and Amphibians." n4. Have children bring frogs and toads to school. Place them in a terrarium.

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
o. Reptiles, which breathe through lungs, are covered with scales or bony plates. Most reptiles lay eggs but some bear their young alive.	o1. Use David C. Cook Teaching Picture "Turtles" and Resource Sheet No. 5.
	o2. Use Society for Visual Education Study Print Set, "Reptiles and Amphibians."
	o3. Encourage the children to bring turtles and snakes to school so that they may be observed by the children.

MATTER

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Matter is the material of which the universe is composed. Matter has weight and occupies space. Existing in various forms and states, it differs in texture, shape and color. Both living and non--living matter is constantly changing.	a1. Identify objects and classify them as to whether they are solids, liquids, or gases.
	a2. Rocks, water, and air are examples of the three states of matter. Show the children a small plastic bag of each and empty the bag to discover what happens to the matter.
	a3. Walk around the school yard frequently and have the children note the changes that have occured in both living and non-living matter.
	a4. Cut out pictures showing the various states of matter and place them upon a chart under the proper heading.
b. The properties that determine the state of a substance are the mass of the substance, the volume it occupies, and the pressure it exerts.	b1. Use Instructor Primary Science Concept Chart "Solids, Liquids, Gases."
	b2. Classify objects in the classroom as to whether they are solids, liquids, or gases.
c. Matter may be a solid. The molecules in solid matter have a greater cohesion than those in liquids or gases. Because of this, solids maintain a definite shape and size. Their shape may only be changed by actions such as cutting, striking, heating, or growing.	c1. Set up a display of objects that are solids.
	c2. Collect pictures of solid objects and classify them as to whether they could be changed by cutting, striking, heating, or growing.
d. Matter may be a liquid. Lesser cohesion results	d1. Pour liquids into various containers so that one may observe how the liquid assumes

CONCEPTS	ACTIVITIES AND RESOURCES
in a greater movement of molecules in liquids. Molecules are attracted to those molecules at the surface so surface tension is present. Liquids assume the shape of their containers but occupy a definite space.	the shape of the container. d2. Try to float a needle on the surface of water and other substances.
e. Matter may be a gas. The cohesion between the molecules is so weak that the molecules are widely separated and the motion of the molecules is very great. The molecules spread out to fill the container in which they are placed.	e1. Light a wooden match and notice how the smoke, a gaseous product moves freely and blends with the atmosphere. e2. Provide the children with balloons that they may blow up. Hold the opening of the balloon under the water and let the air out.
f. Energy is the capacity for doing work, that is for putting matter in motion or changing the direction of matter in motion. Energy in the form of heat can cause matter to change from one form to another. If a certain solid is heated to a certain temperature, it changes to a liquid. If a liquid is heated to a certain temperature, it changes to a gas. A loss of heat works in reverse order from a gas, to a liquid to a solid.	f1. Place an ice cube on the prongs of a fork that is resting on the top of a glass. Note how the ice cube melts and the water in the glass later evaporates. f2. Bring in various substances that will melt easily and become a liquid. f3. Discuss and show a diagram of the water cycle. Warm air rises and loses heat. The matter becomes water drops that join together as a cloud. The drops become too heavy and fall to earth where they eventually evaporate and return to the air as gases. Hold a flat pan over the spout of a teapot. Gases condense on the pan and appear as water vapor.
g. Heat is transmitted by moving particles in	g1. Blindfold a child and have him determine by feeling which of two objects are in

CONCEPTS	ACTIVITIES AND RESOURCES
conduction, convection, and radiation. Conduction is the process by which energy such as heat is transmitted by a medium such as solid, liquid, or gas without movement of the medium. Convection is the movement of heated material through a fluid medium, caused by different densities within the medium. Colder, denser material causes warmer, less dense material to rise. Radiation is the transmission of energy in a straight line from a source such as the sun through a medium such as air, water, or vacuum.	sunlight. g2. Sit on one of two chairs for a few minutes. Feel the heat on the seat of the chair that one is sitting on and compare it to how the other chair feels. g3. Take off one shoe. After a few minutes take off the other shoe and feel it inside and compare it with how the other shoe feels inside. g4. Discuss how warm clothing is worn in winter to prevent the loss of heat from the body. Cooler looser clothing is worn in the summer to permit the loss of weight. g5. Show film, "Light and Heat."
h. The greater the amount of heat the faster the change will occur. The amount of heat influences tha rate of evaporation. The spreading of the substance and moving air hastens evaporation.	h1. Place one jar with the water level marked in a warm place and one in a cold place. Determine the place in which the water will evaporate first. h2. Place two drops of water on a piece of waxed paper. Observe their evaporation. Try it again with two other drops, this time spreading the water drops with a pencil point or blow on it. Watch how water evaporates. h3. Place water in two jars, one covered. In which does water evaporate first?
i. The amount of heat present, temperature, is measured with a thermometer. A degree is the unit of measure on a thermometer. Heat makes the liquid in the thermometer rise. The height of the line	i1. Experiment with a thermometer in the classroom, measuring the temperature in various locations. Make a graph showing the findings by cutting paper strips that are the length of the red line on the thermometer and pasting them on a sheet of paper and labeling them.

CONCEPTS	ACTIVITIES AND RESOURCES
shows the temperature. Every thermometer has a scale to measure temperature.	i2. Look at pairs of thermometers and circle the one showing the higher temperature. i3. Record the outdoor temperature daily. The temperature should be taken at the same time in the same place each day.
j. Physical change occurs when the size, shape, or phase of the matter changes but the chemical composition is not changed.	j1. Taste a cookie and then break it up into pieces. Its size and shape will have changed but it will still taste the same. j2. Salt may be dissolved in water. If the water is heated the salt crystals will reappear. j3. Use Instructor Primary Science Concept Charts "Some Solids Dissolve" and "Physical Change."
k. Chemical changes are those in which material and objects are changed into new substances. Heat, light, electric currents, water, and air are the types of energy needed to start chemical changes. Chemical changes take place when heat is liberated or absorbed; light, electrical energy, and mechanical energy is liberated and a gas or new solid is formed.	k1. Make sun prints by placing a cutout design on a piece of colored construction paper. k2. Burn a candle observing the soot that is given off by the burning wick. If a saucer is held over the burning wick the gaseous particles will be collected on it. k3. Burn a piece of wood in a test tube over a flame. k4. Cut a piece of new wood in two pieces. Place one of the pieces outside where it is exposed to the elements. After two weeks, compare the appearance of the pieces. k5. Use Instructor Primary Science Concept Chart "Chemical Change."
l. Most combustible materials are living or made from things that once were living. Non-living materials such as sand, water, and most metals do not usually burn.	l1. Try to burn various materials classifying them first as living or non-living things. l2. Encourage children to learn what types of containers are usually used for burning.

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
m. Sun is the chief source of heat and light energy. Other sources of heat are chemical action, mechanical energy (resulting from friction), electrical energy and nuclear energy. The other source of light is that artificial light produced by heating materials until they become incandescent.	m1. Place one of two thermometers in the sun and one in the shade and compare the temperatures. m2. Show film "Light for Beginners."
n. As light strikes various kinds of matter it is absorbed, reflected, transmitted, or refracted.	n1. Classify objects as to how light strikes them. Determine whether it is absorbed, reflected, transmitted, or refracted. n2. Discuss various types of materials. Hold the pieces of material in the sunlight and observe how the materials appear as the sunlight shines on them.
o. Light passes through transparent objects easily. Light loses some of its illumination as it passes through translucent objects. Light does not pass through opaque objects at all.	o1. Classify objects as to how light passes through them. o2. Discuss why particular objects may be made out of a transparent, translucent, or opaque material rather than another type of material.
p. Various objects react in different ways to wave lengths of light energy. The color of an object will depend upon the physical properties of an object. Eyes interpret light energy as brightness, darkness, and color.	p1. Arrange a display of objects arranging them according to their color. p2. Read poems and stories about colors so that children may become more conscious of them. p3. Study a large model of an eye to determine its structure. p4. Show film "Color for Beginners."

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
q. A prism separates or disperses the various wave lengths of sunlight and causes them to appear as red, orange, yellow, green, blue, or violet.	q1. Provide the children with prisms so that they may experiment with them and discover the colors in white light. q2. Study and observe rainbows. Observe the position of the colors in the rainbow. Have children draw pictures of the rainbow.

E.S.S. UNIT

ENERGY - PRIMARY BALANCING

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
a. The equal-arm balance is the simplest piece of weighing equipment. The point of support on the arm is in the center. The distance from the pivot to the arms is fixed and equal.	a1. Provide opportunities for the children to experiment with the equal-arm balance. Children will alternate between adding to and taking away objects to achieve balance.
	a2. Children will discover that it will be necessary for them to simplify, to weigh like things against like things and to have the same number of objects on each arm in order to achieve balance.
b. The same amount of volume does not always equal the same amount of weight.	b1. A child places some material in one of the pans. Another child places another type of material in the other pan, trying to balance the amount in the first pan. If he is able to balance the amount in the first pan, he wins.
	b2. Children experiment to learn how much of one substance will balance how much of another. Encourage them to keep records, setting aside the containers of stuff that balance one full cup of a certain stuff.
c. Ratio is the relation between two similar sizes in respect to the number of times the first contains the second.	c1. A full cup of one substance is balanced with one half of the cup of another substance. Discover whether if half of each substance is removed the pans will still balance.
d. The beam of the equal--arm balance must be level if the pan contains materials of equal weight.	d1. Learn whether it makes a difference where the load is placed in the pan.
	d2. Experiment with strings of different lengths. Try using pans of different sizes and weights. Plasticene may be used in compensating for the different sizes and weights.

CONCEPTS	ACTIVITIES AND RESOURCES
	d3. Discover whether an object weighs the same when it is hung from the hook on the balance arm as when it is placed in the pan.
	d4. Learn whether objects that balance on one scale will balance on another scale.
e. Besides balancing things that keep their shape, form, or present substance, balances may also be used to record how and when weight changes. Things may change in weight after something is done to them.	e1. Balance a gerbil with the needed number of beads to discover the gerbil's weight each week.
	e2. Weigh a classroom animal and the amount of food he is going to eat, balancing it against some blocks. After the animal has eaten the food, weigh him again and see if his weight has increased by the amount of food he has eaten.
	e3. Balance two pails of water. Place one outside to freeze. Try to balance the two pails again.
	e4. Balance two dry sponges. Wet one and try to balance them.
	e5. Balance two basketballs. Let the air out of one and balance them again.
	e6. Balance a baby gerbil with his mother. Keep a record and discover when they are equal in weight.
f. There are orderly relationships between weight and shape in objects.	f1. Scaled blocks may be used to discover these orderly relationships. Children may wish to construct matching shapes in each pan.
g. Approximation is something that must be recognized and used. It is fundamental to science.	g1. Children will learn to recognize and use approximation which is fundamental to science. They will for example, discover that some objects, such as blocks of wood will nearly balance rather than absolutely balance.
h. Instruments are necessary for measuring weight because weight does not depend on shape	h1. Weigh two blocks, one of balsawood and one of birch. Discover which is heavier.
	h2. Push BB shots into styrofoam balls. See

CONCEPTS	ACTIVITIES AND RESOURCES
or volume alone and cannot always be judged by senses.	whether the children can feel the difference or whether they need a scale.
	h3. Place several objects out which are close in weight but vary widely in size. Guess the order of heaviness. Several may do this, keeping track of their different orders. Let the children test their differences by weighing the objects against each other. Record predicted orders and order established by balance. Children may choose instead to weigh the objects by balancing them with washers.
	h4. Compare the weights of various pieces of money.
	h5. Weigh cuisinaire rods discovering the weight-length relationship.
	h6. Cover one of the two pans. Have the children determine by what they can see, what is in the covered pan.
i. All standards of weight are arbitrary and one chooses a certain unit for its convenience.	i1. Children bring favorite objects to weigh. They balance them with washers, crayons, or kidney beans.
	i2. Children will discover that not so many weights will be needed if they find or construct some weights that are heavier. They may discover this problem by trying to balance a child in the class with washers. Weighing may be easier done in books with so many washers equaling one book.
	i3. Pound boxes of sugar may be used as weights. If they are too large, they may be divided into ounces.
j. The location of the weight on a lever such as a balance board determines whether the board will balance. Changing the position of the	j1. Let the children discover various ways of balancing the board with uneven weights. Determine whether the balance is affected when a person lies or sits down.
	j2. Try moving the fulcrum in order to achieve balance.

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
fulcrum is another way of manipulating the balance.	j3. Cover the fulcrum with a box. Ask the children to determine where the fulcrum is located.
	j4. Discover where a person's weight goes when the board is balanced by first weighing the board. Then discover the weight of the board with the children standing on it, sitting, and lying. Place scales under the ends of the board. The child stands in various positions on the board. The combined weight shown is the weight of the boy and the board.
k. The four-foot board also shows how the effect of weight varies as its position changes in the system.	k1. The children experiment with different objects in order to make the board balance.
l. Equal weights will balance at any equal distance from the fulcrum. Pairs of blocks added at equal distances from the fulcrum will always balance.	l1. Place blocks on the ends of the balance board.
m. The board may be balanced with an odd number of equal blocks.	m1. The board may be balanced by placing one of the blocks over the fulcrum, by placing two blocks half-way out to balance one block all the way out, or by moving the fulcrum so the board can be counter-balanced with one block.
	m2. The teacher may show the children various arrangements of blocks and help them to determine why the blocks do or do not balance.
	m3. Blocks may sometimes be moved to new positions added or taken away and the board will remain balanced. Try to make the board tilt by doing various things to the blocks on it.

CONCEPTS	ACTIVITIES AND RESOURCES
n. The pegboard beam may be balanced and washers may be hung on it. The beam may be moved off-center and balanced when there.	n1. One child balances the beam with any arrangement he chooses. Another child copies it on the small balance board. Arrangements may also be copied on the four-foot board.
o. Odd shapes may be balanced on fulcrums.	o1. Balance an odd shape on a fulcrum. Discover how many washers may be added to it without destroying the balance.

E.S.S. UNIT

ENERGY - SPINNING TABLES

GRADE ONE

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. A spinning table is a lazy susan that can be turned by hand or with a driving assembly. It may have a smooth chalkboard insert or a pegboard insert. It helps the children to discover more about circular motion.	a1. Provide children opportunities to experiment with the spinning tables.
b. Predict what pattern will occur when a line is drawn.	b1. Before drawing each of the patterns suggested record what one thinks the pattern will look like when it is made. Draw a line with chalk across the spinning table. Draw another line moving one's hand slowly over the table. Compare how the patterns look. Spin the table in the opposite direction and look at the pattern created.
	b2. Draw a line from the middle of the table to the edge trying it at various speeds.
	b3. Draw a line from the edge of the table to the middle turning the table at various speeds. Try turning the table in the opposite direction.
	b4. Try drawing a particular figure on the spinning table while it is spinning slowly. One's hand must move in a circle with the spinning table while drawing the line.
	b5. Try drawing a circle on the table while it is spinning. This can be done when the chalk is held in one position while the table is spun in a circle. Patterns may be drawn with colored chalk.
	b6. Linear motion can be experimented with when a pattern is made on a piece of pattern as it is pulled away.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
c. Predict the order in which events will occur.	c1. Place four marbles which differ in size and weight in holes on the pegboard table. Spin the table slowly at first and then faster and faster. Predict when the marbles will fall off.
	c2. Place the marbles in different patterns. Predict the order in which they will fall off. Determine whether there are any factors that determine the order in which they fall off. Decide whether there is a place where a marble can be put so that it will never fall off.
	c3. Try rolling the marble across the spinning table to another child.
	c4. Try placing various marbles in the center of the table while the table is moving.
	c5. Record the path of a marble across a spinning table by placing a piece of carbon paper and white paper on the table.
	c6. Place blocks of differing weights, shapes, and materials on the table. Predict the order in which the blocks will slide off. Can rules be made for the order in which the blocks slide off?
	c7. Place a block an inch from the center of the table and observe its motion.
	c8. Determine what the sliding motion would look like if one was on the moving table by drawing a line on the table through the center of the table. Place the block one inch from the center and watch the block and line as you increase the speed of the table.
	c9. Observe what happens to a block on a piece of paper as the piece of paper is pulled out from under the block.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
d. Powders and liquids may be affected by circular motion.	d1. Place a container of salt on the spinning table and discover what happens to it after the spinning table has been spun. Does the location of the container, the location of the salt in the container or the shape of the container have any influence on what happens to the contents?
	d2. Spin a rectangular container of water on the table. Does the location of the container, the liquid it contains, or the direction the table is turning affect the results of the spinning?
	d3. Use a round container for the salt. Discover whether the same thing happens to the water that happened to the salt? The water acts differently when spun in the round container than it did in the rectangular container. Learn what happens when a drop of food coloring is added to the round and rectangular container.
	d4. Place the compartmented container one-quarter full of water on the pegboard with one of its ends at the center of the pegboard. Mark the spots where you think the levels of water will be when you spin the table. Does the speed of the table affect the level of the water?
	d5. Place the tube of water on the spinning table at various angles and observe what happens to the bubble in the tube.

E.S.S. UNIT

ENERGY - MIRROR CARDS

GRADE ONE

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. The mirror can be used to complete a design. The cards provide practice in counting. The mirror may be placed on the design.	a1. Half of a familiar object is shown. The child must decide where to place the mirror in order to see the whole design. The child learns to make a picture longer or shorter using the cards in Beginner's Set 1. a2. Placements of the mirror on some cards will result in different pictures in Beginner's Set 1.
b. A picture may be formed and then made to disappear slowly or quickly. It may be made to reappear at will.	b1. Experiment to discover how pictures can be made to appear and disappear.
c. Make a specific picture from a given card. The child must determine which side of the card he has to place the mirror on in order to match the Pattern Card. He must also determine the correct distance from the object at which to place the mirror.	c1. As the child works with Beginner's Sets 2 and 3 he must first pair the cards. He must then match the picture on one card to the picture on its Pattern Card by using a mirror.
d. The child may choose between two directions in placing the mirror.	d1. The rug pattern card requires that the child do this.
e. Patterns on the Pattern Card may be matched by using the mirror on each of the other cards.	e1. Use Sets 4-7, each of which contains one Pattern Card and several other cards. Since some of the cards cannot be matched have the children classify the cards as to whether they can or can't be matched.
f. When the mirror slides along the line made by its edge on the card, the image remains stationary.	f1. The children use Sets 8-21 and determine by placing the mirror on the Mirror Card, which of the patterns on the other mirror cards they can match. Problems which are

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	essentially the same occur in several of the sets. Only the elements of the designs and their positions may differ.

FORCES AND SOURCES OF ENERGY

GRADE ONE

CONCEPTS	ACTIVITIES AND RESOURCES
a. A force is necessary to make things move. More force is needed to lift heavy things than light things.	a1. Ask two children to lift a light table. Then, ask them to lift a heavy table. They may need more children to help them lift the heavy table. a2. Categorize magazine pictures of objects as "Easy to Move" or "Hard to Move."
b. There are two directions in which force can be applied. They are pushing or pulling. Lifting involves a pulling movement until the object to be lifted reaches shoulder height. Then, the movement becomes pushing. One cannot lift things if the force of gravity is stronger than the source of energy trying to lift the object.	b1. Look at pictures and determine whether the people doing work in them are pushing or pulling. b2. Have a child perform a movement and the other children determine whether the child is pushing or pulling.
c. Weight is the measure of the pull of gravity on a given object.	c1. Place baskets to hang by rubber bands. Place objects in the baskets. The greater the weight of the objects, the more the rubber band is stretched. c2. Weigh the children on the school scales and compare their weight and size.
d. Energy is defined as the capacity to do work. Energy is used whenever something is made to move or change its movement. Energy is used to work against the pull of gravity. Another force must overcome the force of gravity	d1. Show the children pictures of various types of work being done. Have them identify the type of energy that is being used. d2. Show the children pictures of the same type of work being done in two different ways. Determine which picture shows less force being used.

CONCEPTS	ACTIVITIES AND RESOURCES
in order to make anything go up.	
e. Energy in one form may be changed to energy in another form. New forms of energy may be discovered and used but they were there all the time.	e1. Demonstrate with a dry cell how electrical energy may be changed to heat and light energy. e2. Visit a dam or explain how a power plant works at a dam.
f. Forms of energy include electrical, chemical, mechanical energy, thermal (heat), radiant (light), sound, and nuclear. The sun is the basic source of the earth's energy. Man uses sources of energy available to him to do more work and do it faster. To work faster requires more energy.	f1. Read Doing Work by Glenn Blough. f2. Display pictures of moving people or objects and identify the form that is being used to move them.
g. Some things have more available energy than others so they can do more work. The greater amount of work done, the greater amount of energy expended.	g1. Collect toys, models and pictures of various machines. Demonstrate how the machines operate and the work that they do. g2. Display pairs of pictures. Decide which picture in each pair requires more energy than the other.
h. Food serves as a source of energy for people and animals. Muscles can be used to move things. People have muscles in various parts of their bodies that enable them to move.	h1. Show the children pictures of people and animals moving things. Ask the children to identify what is being moved, the muscles being used and whether it is a pushing or pulling movement. h2. Collect and mount pictures showing animals using muscles to do work.
i. Fuel may serve as a source of energy for engines. Engines help because they are stronger	i1. Study pictures of old and new ways of doing things. Compare the amounts of effort required.

CONCEPTS	ACTIVITIES AND RESOURCES
than people and can move heavier things, save people hard work, work for longer hours and move faster. Fuel is burned in the motor of an engine to supply energy.	i2. Ask the custodian to demonstrate for the children how the school power lawn mower works.
j. Electricity may serve as a source of energy for machines. A cord runs between an outlet and the switch which shuts off the electricity. Heat comes from a wire that has electricity running through it.	j1. Encourage the children to bring pictures which show electricity as a source of energy for machines.
	j2. Demonstrate the operation of small electrical appliances.
	j3. Take apart an electrical plug and show the children how it is made. Note how the wires are insulated. Point out the danger of playing with wires or appliances.
	j4. Note red wires on toasters, hot plates, or popcorn poppers.
k. Wind, moving air, may serve as a source of energy for machines.	k1. Show pictures of machines or other objects moved by the wind, and discuss the type of work the wind is doing.
	k2. Make a balloon move by blowing air on it with a cardboard fan.
l. Moving water may serve as a source of energy for machines.	l1. Use a stream of water from a hose to move things such as small rocks, toys or sand.
	l2. Discuss how floods move things. Show slides or pictures of flood waters.
	l3. Make a pinwheel of heavy metal foil and hold it in a stream of water.
	l4. Make a model of a flour mill.
m. Springs may serve as a source of energy for machines. One type of spring is a coiled spring in which a force is applied as it uncoils.	m1. Encourage children to bring wind up toys. The spring obtains and stores energy as the key is turned. The spring releases the energy gradually as it unwinds. The released energy makes the object move. The object stops when the spring is unwound.

CONCEPTS	ACTIVITIES AND RESOURCES
The second type of spring exerts force as it contracts or stretches out.	m2. Encourage a child to bring a Jack-in-the--Box because a Jack-in-the-Box has a spring of the second type.
n. Magnets may serve as a source of energy. A magnet exerts force on or pulls magnetic materials. The molecules of a substance such as iron or steel line up in a regular order when the substance becomes a magnet.	n1. Place a variety of objects on a table and ask the children how some of the objects could be moved without touching them. n2. Have the children classify materials as to whether they are magnetic or not.
o. The strength of the magnetic force is greatest near the ends or poles of the magnets. All magnets have poles.	o1. Try holding a nail at different places on a magnet. Discover where it holds on the best. o2. Show films "Michael Discovers the Magnet" and "Magnets for Beginners."
p. Attractive force of a magnet may pass through nonmagnetic materials such as air, glass, water, paper, and wood.	p1. Place a magnetic material under a glass dish. p2. Place a magnet under a piece of paper. Move the magnet to move a magnetic object on top of the paper. You can use this principle to move puppets during a puppet show.
q. Like magnetic poles repel each other and unlike magnetic poles attract each other.	q1. Mark one end of each magnet. Let the children experiment with the magnets to discover how the ends attract and repel each other. q2. Attach a paper clip chain to one end of a bar magnet. The end of the chain will be attracted toward or repelled from the end of the bar magnet.
r. Pieces of iron or steel may be made temporarily magnetic by stroking them with a magnet.	r1. Magnetize the head of a hammer and use it to pick up nails. r2. Magnetize a needle and use it to pick up iron filings, small tacks, or needles.

GRADE ONE

CONCEPTS		ACTIVITIES AND RESOURCES
s. Magnets have many practical uses.	s1.	Have children pick out ways magnets are being used in a picture.
	s2.	List ways magnets are used in the home.
t. Objects alike in appearance and utility have different magnetic properties. Some materials are magnetic and some are not.	t1.	Read book, Mickey's Magnet by Franklyn Branley and Eleanor Vaughan.
	t2.	Show the children forks of different materials and see which the magnets will pick up.
u. The size of a magnet does not determine its strength.	u1.	Determine how much certain magnets can hold by making paper clip chains and determining the amount particular magnets can hold.
	u2.	Place a nail between two horseshoe magnets and pull them apart. Which magnet keeps the nail?
v. Magnets differ in size, shape, and composition. Some are natural (lodestone), permanent (alnico) and manmade. Magnets have different shapes including horseshoes, bars, and cylinders.	v1.	Show children a variety of magnets of different shapes such as magnetic cubes, magnetic letters, and magnetic jigsaw puzzles.
	v2.	Use magnets of a variety of shapes to pick up some objects.
w. Some magnets can make electricity when they are attached to a source of electricity.	w1.	Make an electromagnet from a dry cell battery, the nail, paper clips, and insulated wire. Use the magnet to pick up the paper clips.
	w2.	Discuss how electromagnets are used in doorbells, telephones, telegraph receivers and senders, and by men in factories and junk yards.
x. A compass is a turnable magnetic needle that points north and south to the magnetic poles of the earth. It helps us find direction.	x1.	Encourage children to bring compasses from home and experiment with them. Ask them to inquire how compasses are used.
	x2.	Place a compass next to the direction indicator on a map to show the children its use with a map.

CONCEPTS	ACTIVITIES AND RESOURCES

CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

PATTERN BLOCKS

GRADE ONE

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. Pattern Blocks come in six shapes including green triangles, red trapezoids, wide blue diamonds, orange squares, yellow hexagons, and natural colored narrow diamonds. They are made of 3/8" wood and each side is one inch long except the two-inch side of the trapezoid.	a1. Provide opportunities for the children to manipulate shapes and patterns. They may build structures with them, sort or stack them, make pictures, make assymetrical or symmetrical designs, or try to change one shape to another. a2. Ask the children to make certain objects with their blocks.
b. A pattern is the overall form that results from particular operations and can be an ordering of shapes, words, or numbers. A pattern of shapes can be repeated to make an overall design. It is predictable and can be constructed over and over again.	b1. Ask the children to make various kinds of floors with their blocks. Make floors that start in the middle and work outward. Make floors with just one kind of blocks. Make floors with a mixture of two blocks.
c. When making larger squares, triangles, diamonds, or trapezoids, one will discover that the same number of blocks is required for enlarging.	c1. Encourage the children to make larger squares, triangles, diamonds, or trapezoids from squares, triangles, diamonds, and trapezoids. How large a shape can be made? c2. Compare the shape of one block to a pattern made in the shape. c3. Count the number of blocks in a particular figure and predict how many blocks will be needed for a successive figure.
d. One shape may be made out of other shapes. Many different combinations of sizes, numbers, and shapes are possible.	d1. Make one shape out of the other shapes or a combination of them. d2. Make a shape of a particualr size.

GRADE ONE

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	d3. Make the smallest shape possible out of a particular kind of shape.
e. There are many different ways of arranging blocks.	e1. Children draw outline shapes of their blocks and have the other children fill them in with blocks.
f. Mirrors will change the appearance of shapes.	f1. Provide mirrors with which the children may experiment and discover that they can make some shapes to appear as others.
g. To develop an understanding of area arrangement and rearrangement. A design is the same if all you do is turn it or flip it.	g1. Make various shapes and examine and compare their perimeters. Discover how many different shapes can be made with a set of objects. g2. Determine how many of a particular kind of shape can be made with a certain number of squares.
h. Polygons have equal sides but do not necessarily have equal angles. They are convex.	h1. Have children make polygons of various numbers of sides. h2. Discover different ways to put blocks down along a straight line. h3. Encourage the children to make their own blocks.
i. Symmetry may be shown in many different ways in the construction of shapes.	i1. Ask the children to make shapes containing certain numbers of particualr shapes and arranging them in various ways.

CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

SAND

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. Sand may be defined as any mineral or composition of minerals ground naturally by wind, water, weathering, and tumbling to a particular size range, between 1/16 mm and 2 mm in diameter.	a1. Present the children with sand and have the children identify what it is.
	a2. Discover how sand feels by experimenting with it.
	a3. Determine whether it is a liquid or solid.
b. Discover how sand flows. The big grains usually splash out and pile around the smaller grains of sand.	b1. Observe how sand flows through a paper cup with the end cut off. Difference in sand size determines the size of the opening needed.
c. Large grains of sand are more stationary than small grains of sand.	c1. Make a hole with your finger in a pile of dry sand. You will discover the hole fills up with sand soon.
	c2. Make piles of equal volumes of big, little, and mixed sand. With which can the steepest hill be made?
	c3. Discover whether big or small sand grains can be packed harder.
d. Discover how a pile of sand may be measured.	d1. Measure the diameter of a pile with a ruler.
	d2. Put glue on a pencil and stick it into the center of the pile of sand. Measure the height of the sand on the pencil.
	d3. Measure the circumference of a pile of sand with string.
e. Discover the effect of water on sand. Particles of sand act differently under varying conditions: wet, dry, mixed, sorted, massed, and dispersed.	e1. Determine whether a bigger pile can be made with wet sand than dry sand. What happens to the pile when the sand dries?
	e2. Discover the best method of drying the sand out quickly.

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
	e3. Pour water on a pile of sand and discover how it moves.
f. There is equal air space around big and small sand grains.	f1. Add large and small grains of sand in small amounts to equal volumes of water and compare the change in water level.
g. Grains of sand are different sizes. Different sizes of grains of sand are different colors in the E.S.S. Unit. Particle size affects the way the material behaves.	g1. Sort out different sizes of sand grains with sieves of three different sizes.
	g2. Sand may be sorted in a pan of water because large grains of sand sink to the bottom of the pan first.
	g3. Sand may be sorted in a tube that contains a large amount of water and a small amount of mixed sand. The sand settles according to size when it is shaken in the tube.
	g4. Tap a tray of sand and the sand will line up by sizes. Discover which size of sand grains slide first when the tray is tipped. Discover the angle of the slope needed to make various sizes of grains move.
	g5. Discover how sand slides on other surfaces such as waxed paper or cloth.
h. There are many different sources of sand.	h1. Obtain samples of sand from sources such as sandboxes, roadsides, beaches, and river beds.
i. Sand grains are irregular in shape.	i1. Study grains of salt, sugar, and rice and draw their shape which is regular in appearance compared to the sand.
j. There are many different colors of natural sand. The color of natural sand depends upon the kind of rock from which the sand grains come.	j1. Classify the grains of natural sand according to color or shade.
k. Natural sand may have magnetite in it.	k1. Place a magnet in a dish of sand and see whether any particles are attracted to it.

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
l. Sand and soil differ in composition. Soil may contain crushed decayed leaves, crushed dried grass, and sand.	l1. Examine samples of soil and sand under a hand lens.
	l2. Discover whether it makes a difference if plants are grown in sand or soil.
	l3. Does the difference of the size of the grains of sand affect the growth of a plant?
	l4. Weigh a cup of soil and a cup of sand and discover whether there is a difference in weight.
m. Be aware that sand is made by natural abrasion. Granite rocks are hard to crush while conglonerate, sandstone, limestone, and bricks are easier to crush.	m1. Place rocks in a bag and hit them with a hammer.
	m2. Shape pieces of broken rocks such as limestone chips in a coke bottle containing water. One can see how chips tumble and wear into grains.
	m3. Discover whether sand grains can be made smaller by shaking them. Sand is virtually indestructible in the natural environment. A small grain of sand has survived wind, rain, and friction and is as small as it is going to get.
	m4. Examine the size, shape, and colors of the grains of sand made and compare them to natural sand. Place grains in order of size from largest to smallest.
	m5. Discover whether rocks can be make from sand.
n. Sand may be colored with food coloring. The sand will be darker if more color is added. It will be lighter if more sand is added. Different colors may be combined to make new colors.	n1. Try coloring sand with different materials such as Easter egg dye, melted crayons, paint, colored chalk, or food coloring.
	n2. Discover how the color of the sand may be made lighter or darker.
	n3. Try mixing colors.
	n4. Try to match a color made previously.
	n5. Discover whether the mixture of two colors

CONCEPTS	ACTIVITIES AND RESOURCES
	may appear to be a different color when one is a certain distance from the sand.
o. Visual and textural effects may be achieved with the use of sand, through the knowledge of the size, color, and shape of sand.	o1. Make murals and sand paintings.
	o2. Layer colored sand in a jar to serve as a paper weight.
	o3. Sculpt with a sand, wheat paste, and water mixture.
	o4. A few lines of sand on a sheet of paper may serve as a stimulus for original stories, poems, songs, and dances.
p. Sand on sandpaper is used as an abrasive and has an effect on materials. The effect it has is a function of the size, shape, and hardness of the sand used.	p1. Children make sandpaper. Observe how sandpaper affects various materials and what happens to sandpaper after it has been used.
	p2. Children bring in different samples of sandpaper. Scrape off the sand and examine it under a magnifying glass and compare it to other sands observed.
	p3. Discover whether sand is the only material that makes rough paper by trying materials such as salt, sugar, rice, chalk, dust, and seeds and trying to sand with them.
q. Sand may be used as a material in the development of the understanding of balancing.	q1. Discover whether the pans balance when they are empty.
	q2. Discover whether pans balance when there is something in only one pan.
	q3. Find out whether a cup of sand will balance a cup of seeds, nails, or sawdust.
	q4. Find out whether two cups of the same thing will balance each other.
	q5. Learn whether a cup of large sand grains will balance a cup of small sand grains.
	q6. Discover whether water can be added to cups of large grained and small grained sand and determine how many spoonfuls can be added to

CONCEPTS	ACTIVITIES AND RESOURCES
	each.
	q7. Encourage the children to make their own balancing scales.
r. Develop an understanding of volume by using sand.	r1. Determine which is the largest of several containers by using sand to discover which holds the most.
	r2. Arrange containers in order from the largest to the smallest.
	r3. Will the volume of a container change if it is turned on its side?
s. Learn how length may be measured.	s1. Discover how long a line one can make with a cup of sand.
	s2. Learn how one can make the fattest, narrowest, shortest, longest, or highest line with one cup of sand by experimenting with and discovering whether the size of the hole, the height from the ground at which the cup is held, the size of the sand, the amount of the sand, the speed of walking, or the rate of sand flow is the most influential factor in determining the type of line that is formed.
	s3. If a certain amount of sand leaves the container in a certain time, how much would leave in half that time?
	s4. Learn that different patterns may be made by jumping, running, or walking slowly and try to determine how a particular sand pattern was made.
	s5. Use string, feet, and measuring wheels to determine how long a line of sand is.
t. Sand may be used to measure time and to develop a greater sense of time.	t1. Make timers. This activity uses information learned earlier about sand size, sorting, and flowing.
	t2. Measure the amount of time it takes a certain amount of sand to leave a container

CONCEPTS	ACTIVITIES AND RESOURCES
	by counting, using the second hand of a clock, and marking the level of sand on the outside of the container at the beginning and end of a certain time period.
	t3. Figure out how the container may be emptied more quickly or more slowly.
	t4. Does the height of the container above the ground influence the amount of time it takes the container to empty?
	t5. Find out the longest time it takes a container to empty.
	t6. Learn whether the same amount of sand always takes the same amount of time to empty out of a container.
u. A sand pendulum can be used to make a pattern of its motion.	u1. See what patterns can be made when sand flows from a swinging cup. Sand flowing from a pendulum leaves patterns of its motion.
	u2. Figure out different ways in which a sand pendulum may be hung.
	u3. Design and build sand pendulums.
	u4. Decide how you can change the patterns that the sand flow makes.
	u5. How does different sizes of sand influence the flow?
	u6. Can other materials such as rice, salt, sugar, flour, seeds or water be used in a pendulum?

THE EARTH

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. The earth is spherical in shape.	a1. Show the children some globes and models of the earth.
b. It takes the earth one year to revolve around the sun.	b1. Discuss with the children how many times they have been around the sun. Discover whether they know how many times their parents have been around the sun.
	b2. Have children represent the sun and the earth. The "earth" orbits around the "sun."
c. The earth rotates from west to east.	c1. Place a mark on the globe where you would be located. Turn the globe so that the children may see how the earth rotates.
d. Gravity holds things to the earth. Up is away from the earth. Down is toward the center of the earth.	d1. Toss a ball up into the air. Notice how it falls back to earth after a while.
	d2. Hold an object such as a book with your arm extended. Pretty soon you will no longer be able to hold the object and it will drop to the ground.
	d3. List ways in which gravity helps us.
	d4. Write stories telling what it would be like on earth if there were no gravity.
e. The pull due to the force of gravity is exerted in the direction of the center of the earth. The measure of the gravity's pull on an object is the object's weight. The closer an object moves to the earth, the greater its weight increases. As an object moves away from the earth its weight decreases.	e1. Weigh various objects on a scale to determine their weight.
	e2. Have the children drop various objects to discover whether they are all pulled toward the center of the earth.
	e3. Pick up stones of various weights and sizes and note how the force of gravity pulls them down.

CONCEPTS	ACTIVITIES AND RESOURCES
f. Weight and size are not necessarily related. The density of volume of an object determines the object's weight.	f1. Fill one box with heavy objects and another box of the same size with paper. Discover that the weight of an object depends on the amount of material and the kind of material being weighed. f2. Compare objects such as a balloon and stone as to their size and weight. The balloon is bigger and the stone is smaller but the stone weighs more.
g. A globe is a model of the earth which shows the shape of the earth, position of the poles, circular line of the equator, land masses, and bodies of water.	g1. Examine the globe carefully, discovering what each of the colors represent and comparing the sizes of various parts. g2. Show filmstrip, "The Globe."
h. Earth changes are caused by earthquakes, weathering, erosion, volcanism, and water. Weathering is the breaking down of rocks into small particles. Erosion is the movement by water and wind of rock and soil from one place to another.	h1. Show filmstrip, "The Earth is Always Changing." h2. Visit a river or stream close to school. Observe the action of the water wearing on the banks. h3. Read booklet, Soil, published by American Book Company. h4. Observe a pile of dirt on the playground periodically. Note how the soil washes away and how the soil is moved. h5. Read Glaciers by Wendell V. Tangborn.
i. Land is solid rock covered by rock fragments of gravel, sand, soil, and clay. The order of breakdown is from rocks, to sand, to clay, to soil. Rocks, sand, clay, and soil are the four different types of soil.	i1. Have children collect samples of soil from various locations. Label them as to their source. Compare them as to color and to content. Sort out the soil samples as to type. i2. Pound up some rocks to see how they break into particles.

CONCEPTS	ACTIVITIES AND RESOURCES
j. Land is found in various stages of breakdown such as rock, dry desert lands, sandy beaches, mountains, swamps, gravel pits, and other pits.	j1. Show children slides which picture various types of land.
	j2. Show film, "Lands and Waters of Our Earth."
k. Rocks are divided into three main groups including igneous rock which is formed from molten materials deep inside the earth which reach the earth's surface through volcanoes or cracks, sedimentary rock which is formed on the bottom of oceans and lakes, metamorphic rock which is rock that has been changed by heat and pressure.	k1. Have children bring rocks from home and identify them as to the major type which they are.
	k2. Encourage the children to collect rocks.
	k3. Show film, "Rocks: Where They Come From."
	k4. Show filmstrip, "Rocks and How They Change."
	k5. Show film, "Finding Out About Rocks."
	k6. Read The Wonder of Stones by Roma Gans.
l. Rocks differ in color, weight, hardness, and coarseness or fineness of grain.	l1. Have the children classify their rocks as to the characteristics they possess.
	l2. Look at boxes of rock samples owned by the school and classify them as to color, weight, hardness, and coarseness or fineness of grain.
m. Clay is rock changed into fine powder.	m1. Find some natural clay and have the children mix it with water. Discover its stickiness.
	m2. Mix commercial dry clay with water and allow the children to make things from it.
n. Sand is rock broken into particles by weather, wind, and water.	n1. Observe the size and texture of various grains of sand within a sample.
	n2. Show the class a picture of sand dunes.
o. Soil covers most of the earth. It consists of broken rock particles which are classified as sand, silt, clay,	o1 List the items found in a sample of soil.
	o2. Place a cup of soil in a jar of water and shake it vigorously. After the soil settles, you will be able to see the layers of soil.

CONCEPTS	ACTIVITIES AND RESOURCES
and decayed organic materials.	
p. Topsoil is the top layer of soil containing sand, silt, clay, and humus. Subsoil consists mostly of coarse rock particles. Bedrock is the solid layer of the earth's crust.	p1. Look at an exposed or cut hillside or excavation for a home and observe the layers of soil and rock. p2. Show the children a copy of the diagram of the cross section of the earth that appears in the Teacher's Edition of Today's Basic Science 2, Harper and Row, 1967, page 89.

SEASONS

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. The earth is tilted at a $23\frac{1}{2}^{\circ}$ angle as it rotates around the sun. Because of this tilt and because of the earth's revolution around the sun, the earth has different seasons.	a1. Examine a Trippensee Planetarium to observe how the earth revolves around the sun. a2. Examine a diagram such as that on page 14 in the Teacher's Edition of Today Basic Science, Harper and Row which shows where it is each season in relationship to the sun.
b. The year is divided into four seasons. Fall usually begins about September 22. Winter usually begins about December 21. Spring usually begins about March 21. Summer usually begins about June 21. The fall months are September, October, and November. The winter months are December, January, and February. March, April and May are the spring months. June, July, and August are the summer months.	b1. Use Silver Burdett Biological Chart 2, "Four Seasons." b2. Provide each child with a calendar for the current year. Have them find the date upon which each season starts and note whether there is a notation on the calendar. Classify or divide the months as to the season in which each falls. b3. Have the children list activities in which they can partake during each season.
c. The season in any particular place on earth is determined by the angle at which the sun's rays strike the earth at that place. The closer the sun's rays are to being vertical to a particular place, the more concentrated the energy of the sun is at that particular place.	c1. Tape a cylinder of paper to the end of a flashlight and shine the flashlight directly on the chalkboard. Outline the beam of light with chalk. Hold the flashlight so that the light shines on the chalkboard at a slant. Is the circle of light as bright as it was the first time? Outline the beam of light with chalk and determine whether the light covered more area the second time than it did the first. c2. Measure the temperature with a thermometer

CONCEPTS	ACTIVITIES AND RESOURCES
	at various times during the year and discover the relationship between the temperature and the season.
d. The season in a particular place is also determined by the length of time that a particular spot on earth has day light each day.	d1. One can find out whether longer days help make the weather warmer by heating water under a light for 8 minutes and then turning off the light for 16 minutes. Measure the temperature of the weather. Then turn on the light for 16 minutes and then turn it off for 8 minutes. Measure the temperature again. At which time was the water warmer? Which season would each part of the experiment represent?
	d2. Each day keep a record of when the sun rises and when the sun sets, obtaining the information for this from the newspaper or from observations.
e. When the northern hemisphere is tilted toward the sun, the northern hemisphere has summer. When it is tilted away, the northern hemisphere has winter.	e1. Show film, "Seasons of the Year."
	e2. Show filmstrip, "Seasons."
f. Some animals hibernate during the winter, Hibernation is a condition in which the body temperature is markedly lowered. There is also a drop in metabolism, heart rate, respiration, and other vital functions. Some animals such as squirrels, chipmunks, and skunks hibernate only when the weather is severe. Animals usually hibernate in a place that has the same temperature much of the time	f1. Prepare chart of the "Hibernation Stump" pictured on page 324 of the Teacher's Edition of Science for Here and Now 2, published by Heath.
	f2. Show film, "Animals in Fall."
	f3. Read Animals in Winter by Henrietta Bancroft and Richard Van Gilder.
	f4. Use David C. Cook Teaching Picture, "Winter Hibernation," and Resource Sheet No. 10.

CONCEPTS	ACTIVITIES AND RESOURCES
such as hollow logs, caves, and piles of leaves or brush. Fat in a hibernating animal represents the excess food that has accumulated in the body and has not been used for growth, repair and energy. This fat is broken down and used as a food supply while the animal is hibernating.	
g. Some birds and other animals migrate south in the winter. The decrease in the length of the day seems to be the stimulus for the birds to fly south. Migrating birds follow the same flyways each year. Birds may be guided by the stars or by the magnetic field of the earth. They may store extra food in their bodies before they migrate. The distances that birds migrate vary widely. They return in the spring to build their nests.	g1. Read The Butterflies Come by Politi. g2. Keep a record of the birds that the children see and observe which ones are no longer present during the winter months. g3. Use David C. Cook Teaching Picture, "Winter Migration" and Resource Sheet No. 12.
h. Birds vary widely in their eating habits and their eating habits determine whether they migrate or not. Birds that do not migrate in winter live on seeds, fruits, insects, and other foods that they can find.	h1. Read Birds Eat and Eat and Eat by Roma Gans. h2. Read Winter Tree Birds by Lucy Ozone and John Hawkinson. h3. Use the Society for Visual Education Study Print, "Feeding the Winter Birds," from the "In the Winter" set.
i. Some animals store food for winter.	i1. Observe a squirrel gathering nuts and note where he stores them. Discuss how oak trees

CONCEPTS	ACTIVITIES AND RESOURCES
	may grow from forgotten acorns.
	i2. Use David C. Cook Teaching Picture, "Squirrels," and Resource Sheet No. 9.
j. Insects live through the winter in undeveloped stages such as egg, larva, or pupa. Some insects such as moths and butterflies spin chrysalises or cocoons in the fall and spend the winter in them emerging in the spring. Insects can not live in the winter because the plants upon which they depend for food have died. The insect eggs hatch in the spring.	j1. Examine and cut apart a cocoon, discovering the layers of fibers and materials that it contains and its construction.
	j2. Collect several cocoons and chrysalises and observe the insects' emergence from them.
k. Some animals' fur becomes thick in the fall.	k1. Observe a pet dog's fur.
	k2. Discuss why an animal's fur would become thicker in the fall and the need for it.
l. The color of the fur of some animals such as snowshoe rabbits or weasels change color in the fall so that they will be protected from their enemies during the winter. Then, their fur turns back to its regular color in the spring.	l1. Use Silver Burdett Biological Science Chart 6 "Protective Coloration," which pictures a rabbit and weasel at various seasons.
	l2. Obtain a chameleon and observe how it changes color.
	l3. Use Society for Visual Education Study Print, "A Mink in its Winter Coat" from the "In the Winter" set.
m. Very high and low temperatures inhibit the growth of plants and affect the life processes of the plants. Ground has to be a certain temperature before seeds will start to grow in the spring.	m1. Place one plant in a refrigerator and another outside of a refrigerator. Measure their height as you do this. After a period of time has passed, measure them again and observe which has grown more.
	m2. Place a pot of dirt with seeds planted in it in the refrigerator. Place another one outside. Do seeds in both containers grow?

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
n. Underground parts of some perennials remain alive during the winter and send up shoots in the spring.	n1. Plant some bulbs on the school grounds in the fall. Observe what happens to them in the spring.
	n2. Take a field trip to a wild flower garden and observe the flowers blooming in the early spring in their natural state.
o. When weather gets cold in the fall, chlorophyll in the leaves is not remade as fast as it breaksdown so the green color disappears. The valuable food materials are transferred from the leaves to the other parts of the plant. A layer of cells is built up across the end of the leaf--stem. The leaf-stem breaks off and the wound becomes water proof. Leaves fall when the food and water from the stem is cut off by a layer of cells formed at the end of the stem. The weathering and drying of the leaves is accompanied by the destruction of the reds and yellows in the leaves leaving only the brown of the dead leaves.	o1. To show the effect of shorter hours of sunlight on plants, cover one of two plants with a box for several hours a day. The chlorophyll will breakdown or disappear from the leaves.
	o2. Encourage the children to observe a tree, describing its appearance at various times during the year.
	o3. Collect different types of leaves that have fallen from trees.
	o4. Use David C. Cook Teacher Picture, "Fall Trees" and Resource Sheet No. 7.
	o5. Read *Down Come the Leaves* by Henrietta Bancroft.
p. Trees or shrubs that shed their leaves in the fall are called deciduous plants. Evergreens keep their leaves longer than a year and shed their leaves or needles at different times during the year.	p1. Encourage the children to pick up evergreen needles when they find them and notice what season it is when the needles are being shed.
	p2. Observe a group of trees and notice the dates when each begins to shed its leaves.

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
q. Plants can not obtain water in the winter. The shedding of the leaves prevent the excessive evaporation which would have taken place had the leaves been there.	q1. Obtain two plants and water only one of them. Observe what happens to the plant that receives no water.
	q2. Place a potted plant in a plastic bag and observe the moisture which is given off by the leaves and collected in the bag.
r. Protective bud scales form on the ends of twigs and keep the twigs from drying out during the winter. Leaves form inside the buds during the winter. In spring, the buds swell and the leaves become larger and open.	r1. Remove scales from buds with a toothpick. Count the number of leaves forming inside the bud.
	r2. Place twigs in water and watch the leaves come out.
s. Winter is not the same in all parts of the country.	s1. Use Society for Visual Education Study Print, "Picking Oranges" from the "In the Winter" set.
	s2. Encourage children to bring slides taken during winter in Florida, California, or other southern states.
t. Seasonal changes affect the activities of people.	t1. Use Society for Visual Education Study Prints, "Snowstorm in the City," "Skiing with Father," "Making a Snowman," "Cleaning Snow from Streets" from the "In the Winter" set.
	t2. Use Society for Visual Education filmstrip set, "Learning About the Seasons" including "A Walk in the Rain," "Going on a Picnic," "When Autumn Comes," and "Getting Ready for Winter."
	t3. List the activities which people engage in at various seasons of the year.

PLANTS

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. A seed contains a tiny embryo. Germination will occur and a plant will grow if it is provided with the right conditions of air, moisture, and warmth. Food and nutrients are available to the sprouting plants in the cotyledons, the food storage leaves in the seeds. The seed absorbs moisture and the seed coating either bursts or is penetrated by the embryo's tiny root. Roots, growing into the soil, take up water. Stems grow and leaves develop. The plant produces its own food. A seed grows into a plant like that from which it came.	a1. Place a variety of seeds in a piece of wet cloth. Observe how they have germinated after a few days. a2. Show film, "Seeds Grow into Plants." a3. Show film, "How Does a Garden Grow?" a4. Open a lima bean seed and observe the parts of the new plant including the leaves, stem, roots, and note the color. a5. Start two pots of lima bean seeds. After the seedlings have started to grow, remove the seed parts from one plant. Observe the growth of the plants. a6. Use David C. Cook Teaching Picture, "Planting a Garden," and Resource Sheet No. 3. a7. Read How a Seed Grows by Helene Jordan.
b. Plants are composed of parts usually including roots, stems, leaves, flowers, fruits, and seeds. Leaves grow up and roots grow down.	b1. Draw a line from each part of a plant in a picture to its name. b2. Give each child a small plant such as grass and have him identify the various parts. b3. Grow radish seeds in a glass with a small amount of water in it. Place the seeds between a blotter and the glass. The stem grows up, roots down. Place a stick or other object in the bottom part of the glass. The roots will grow around the object.
c. Roots grow downward and spread out underground	c1. Pull weeds and soak the roots in water so that one may examine the root systems.

CONCEPTS	ACTIVITIES AND RESOURCES
anchoring the plants to the soil. The roots absorb nutrients from the soil.	c2. Examine how the roots of a tree grow.
d. Stems, which store food and support leaves and flowers contain tubes through which the nutrients move from the roots to the leaves, flowers, and fruits.	d1. Place a stalk of celery in a container of red food coloring. Place the container in sunlight. The food coloring will move up through the stem. This demonstrates how water moves up the stem of the plant.
e. A plant's food is manufactured in its leaves where light energy is used to change materials from water and air to food.	e1. Read Basic Science Education Series booklet, Leaves. e2. Cut all the leaves off a plant and discover what happens to the plant. e3. Examine leaves and compare their size, shape, texture, and shade of green. e4. Show filmstrip, "Trees."
f. The flower is the organ of reproduction. A pistil forms at the center of the flower. Stamens form above the pistil. Anthers, tiny bulblike structures in which pollen forms, form at the top of the stamens. Pollen grains are carried by the wind, by gravity or by insects to the top of the pistil of a flower. A pollen tube grows down through the pistil into the ovary which contains ovules in which there are egg cells. Sperm cells unite with an egg cell. A new plant forms from these united cells.	f1. View film, "Learning About Flowers." f2. Read The Flower by M.L. Downer. f3. Record the various stages of a flower by studying a pot of marigolds. Color the squares on a calendar red for the number of days a flower blooms. Color the squares yellow on the days on which the plant is dying. Color the squares green for the days when the petals are gone until the seed pod is fully developed. Open the pod and look at the seeds.

	CONCEPTS		ACTIVITIES AND RESOURCES
g.	After the petals fade and fall off a flower, a seed grows in the bottom of each flower which is left. The seed is formed inside a covering of some type. Seeds differ in size, shape, covering, and color.	g1.	Count the number of seeds in a poppy pod and observe their color, shape, and markings.
		g2.	View film, "Learning About Seeds."
		g3.	Read the following poem: Seeds Seeds are funny, funny, things. Some have stickers, Some have wings, Some are big And some are small, Some, round and flat, Some like a ball. Some are hidden inside of fruits, Some in pods, Or underground roots. Some seeds are foods, And good to eat-- Like corns and beans Or nuts for a treat. But whatever the kind Or wherever it's found-- Most plants grow From a seed in the ground.
		g4.	Obtain various types of seeds, break them open and examine them with a magnifying glass. List the way in which seeds are alike and different.
h.	Seeds from plants may be ejected, squeezed out, or carried away by wind, animals, or water.	h1.	Read Seeds by Wind and Water by Helene Jordans.
		h2.	Use David C. Cook Teaching Picture, "Seeds That Travel," and Resource Sheet No. 8.
		h3.	Bring a pot of soil from the playground into the classroom. Examine it with a magnifying glass. Water the pot of soil and observe whether anything grows in it.
		h4.	Gather and classify seeds as to whether they travel through air, by animals, by themselves, by water, or by man.
		h5.	Read, We Read About Seeds and How They Grow, Webster Junior Science Series.

CONCEPTS	ACTIVITIES AND RESOURCES
i. New plants may be grown from seeds, bulbs, tubers, cuttings, corms, rhizomes, and runners.	i1. Grow sweet potatoes and carrot tops to show new plants may develop from roots.
	i2. Observe a clump of grass in the spring and notice the new shoots of grass appearing. The dried grass is not turning green.
	i3. View film, "Wonders of Plant Growth."
	i4. View film, "Plants That Grow From Leaves, Stems, and Roots."
	i5. View filmstrip, "Finding Out About Seeds, Bulbs, and Slips."
j. A bulb is a short stem surrounded by layers of fleshy, scale-like leaves that are filled with stored food. The dry outer leaves protect the fleshy leaves inside.	j1. Make a cross-section of a bulb diagram on the board. Point out the baby plant, flattened stems, roots, and thick, pale leaves in which food is stored.
	j2. Cut a cross-section out of an onion, a bulb, and observe the parts of the bulb.
	j3. Grow some narcissus bulbs in the classroom.
	j4. Grow bulbs in pots and bring them into the classroom when they are ready to bloom.
	j5. Plant onion seeds and onion sets. Observe which comes up first.
	j6. Plant marigold seeds and color on a stick the height of the seedling each day. Discover how many days it takes the plant to grow the first inch, the second inch, etc. Plant bulbs and observe how many days it takes the bulb to grow the first inch, the second inch, etc. Record the height of the plants each day. Compare the growth of the marigolds and bulbs.
k. Perennials form buds in late summer, store food in their stems and roots, shed their leaves in autumn, and produce a new crop of	k1. Bring a branch with buds into the classroom and put it into water. Keep a chart checking on which day the buds swell, the day on which green tips appear on the buds, and when the tiny leaves first show.

CONCEPTS	ACTIVITIES AND RESOURCES
leaves from their buds in spring. Buds consist of scales, leafy parts, and surrounding tissue made of leaves and flowers. Overlapping waterproof scales protect the leaves and flowers from loss of moisture during the winter and from injury.	k2. Adopt a tree in the schoolyard noting when the first leaves or flowers appear in spring and when the leaves are shed in the fall.
	k3. Use David C. Cook Teaching Picture, "Trees" and Resource Sheet No. 6.
	k4. Read A Tree is a Plant by Clyde Bulla.
l. Plants need food, water, light, and air in order to live. Their growth is affected by the amount of each that they receive.	l1. Show film, "Let's Watch Plants Grow."
	l2. Show film, "What Plants Need for Growth."
	l3. Show filmstrip, "Finding Out How Plants Grow."
	l4. Show film, "Planting Our Garden."
m. Plants need food in order to live.	m1. Grow two plants; one in a jar with dirt and one in a jar with stones. Observe and compare their growth.
	m2. Grow one plant in dirt and another in sand and compare the growth of the two plants.
n. Plants need water in order to live.	n1. Use David C. Cook Teaching Picture, "Plants Need Rain," and Resource Sheet No. 2.
	n2. Place one sweet potato vine in a glass of water and one in an empty container. Discover what happens to the plant without water.
o. Plants need light in order to live.	o1. Start two plants such as geraniums or coleus. After both are growing well, cover one with a paper bag. Continue to water both. Uncover the plant after one week and notice its appearance.
	o2. Read Wait for the Sunshine by Glenn Blough.
	o3. Show film, "How Sunshine Helps Us."
	o4. Cover up a spot of grass for a few days and

CONCEPTS	ACTIVITIES AND RESOURCES
	notice how the grass turns yellow or dies because it does not have light. o5. Use David C. Cook Teaching Picture, "Plants Need Sunshine," and Resource Sheet No. 1.
p. Plants need air in order to live.	p1. Grow bird seed placing containers in three different locations including in a refrigerator, a radiator, and a place with a moderate temperature. Place thermometers in each spot. Compare the growth of the plants. p2. Start two plants. Place one outside in freezing weather. Leave the other one in the classroom. Note what happens to the one outside.
q. Environments are different because of different amounts of food, water, light, and air. All plants have certain common requirements. Different species have adapted for life in different kinds of environments. A certain plant or plants predominate in a particular ecological niche because it has adapted well to a particular situation.	q1. Place a bean plant in water to grow. Place a water plant in dirt to grow. Compare how they grow. q2. Use David C. Cook Teaching Picture, "Plants That Grow in Strange Places," and Resource Sheet No. 12. q3. Read *The True Book of Oceans* by Katharine Carter. q4. Read *The True Book of Deserts* by Else Power.
r. Parts of plants are used for food. One eats the leaves of such plants as cabbage, lettuce, and spinach. One eats the roots of carrots, parsnips, radishes, and beets. One eats the stems of celery, rhubarb, and asparagas. One eats the fruit of tomatoes, raspberries, and	r1. Record the names of all the plants you eat for a week. r2. View film, "How Plants Help Us." r3. View filmstrip, "Plants We Know."

CONCEPTS	ACTIVITIES AND RESOURCES
cucumbers. You eat the seeds of grains such as wheat, corn, and rice. You eat flowers of broccoli and cauliflower.	
s. Wood from trees is used for furniture and paper.	s1. Show film, "How Trees Help Us." s2. Read *Pogo's Letter* by Jo Norling.
t. Cotton and flax are used to make thread.	t1. Discover which of your clothes are made from cotton or linen or are part cotton and linen. The labels on a garment will indicate the fiber content of the material from which it is made. t2. Show the children cotton bolls and demonstrate how the seeds must be removed from the cotton. Twist the pieces of fiber to show how they would have to be twisted to be made into cloth.

ANIMALS

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. All living things move, change, grow, satisfy their needs, and produce other living things of the same kind.	a1. Determine whether an object is a living thing by measuring it against the criteria listed. a2. Classify pictures of objects as to whether they show living or non-living things. a3. Show film, "Living and Non-Living Things."
b. All living things are made up of cells which are made of protoplasm. Living things grow as the cells of which they are made grow and increase in number.	b1. Read *Aug's Microscope* by Millicent Selsam. b2. Look at commercially prepared slides picturing cells through microscopes.
c. Animals differ in size, shape, color, body coverings, where they live, length of life and the kind of food they eat.	c1. Observe a gerbil and list the ways in which it is different from and like a human being. c2. Show film, "Animals are Different and Alike." c3. Make a simple graph with labeled strips of colored paper showing the relative sizes of animals.
d. Animals are alike in that they all move, need food, need water, breathe air, reproduce their own kind and live where they can find what they need.	d1. Have children name all the animals that they can think of in one minute. d2. Show film, "Let's Look at Animals."
e. Animals use certain parts of their bodies to move in order to catch or reach food, to escape from enemies, or to migrate. The way that an animal moves depends on the structure of his legs and the situation that he is in.	e1. Find pictures of various animals in motion. Label each picture with the name of the animal and the type of locomotion it is using. e2. Show film, "Animals Protect Themselves."

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
Each kind of animal has its own characteristic way of moving. Body parts make it possible for them to move in a characteristic way.	
f. Food provides animals with the energy and materials that they need for growth. Each animal has specialized body structures adapted for food getting. Herbivorous animals are plant eaters and eat leaves, stems, fruits and other parts of plants. Carnivorous animals are those that eat meat. Omnivorous animals use both plants and animals as food.	f1. Read Spider Silk by Augasta Goldin. f2. Show film, "Animals and Their Foods." f3. Read Birds Eat and Eat and Eat by Roma Gans. f4. Classify animals according to whether they eat plants, those that eat animals, and those that eat both plants and animals. f5. Make chart of animals seen listing name of animal, kind of animal, the food it eats, type of locomotion it uses and a description of its body discovering. f6. Discuss pets that use other animals for food. Determine the content of pet food. Classify foods eaten as to plant or animal sources.
g. A "food chain" is the sequence or pattern in which living things use other living things for food. For example: a monarch butterfly eats milkweed plants, a dragonfly eats the monarch butterfly, a frog eats the dragonfly, and a fish eats the frog and a man eats the fish.	g1. Collect pictures of plants and animals and arrange them to show "food chains." g2. Classify foods eaten as to their plant or animal sources.
h. When animals are unable to obtain food in their natural environment during the winter because of cold and snow some hibernate for all or part of the winter, some migrate to a warmer climate, some store food and some remain in a pupa stage in the ground.	h1. Read the following books: Animals in Winter by Henrietta Bancroft and Richard Van Gelder. h2. Show films, "How Animals Live in Winter"and "Winter Comes to the Forest."

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
i. Different types of animals survive in different land environments or climates. Higher animals have body adaptations that enable them to survive in their typical environment. These specialized structures and functions enable these different living things to survive without competing directly with all other living things.	i1. Use the following Instructo Flannel Board Aids: "Animals in Streams and Ponds" "Animals in the Woods" "Animals in the Field" i2. Read The True Book of Deserts by Elsa Posell i3. Read, We Read About Animals and Where They Live by Harold E. Tannenbaum and Nathan Stillman i4. Show the following films: "We Explore Ocean Life" "We Explore the Beach" "We Explore the Desert" "We Explore the Field and Meadow" "We Explore the Stream" "We Explore the Woodland"
j. There are many kinds of animal homes. The type of home which an animal makes depends upon the purpose for which it is to be used. Some animals have no homes and some carry their homes about with them. Animals differ greatly in their needs for shelter and in methods of satisfying their need.	j1. Read the following books: Watch Honeybees With Me by Judy Hawes It's Hesting Time by Roma Gans The True Book of Animal Homes by Illa Podendorf. j2. Show the following films: "Animals and Their Homes" "Insects and Their Homes" "Birds and Their Homes" j3. Determine how each house helps to satisfy the shelter needs of the animal or animals occupying it.
k. Animals come from pre-existing parents. Even though there may be slight differences in color, size o shape of mammals usually offspring resembles its parents more than it does other animals.	k1. Match pictures of baby animals with their parents. k2. A chart on page 43 of Today's Basic Science 2 Teachers Edition publushed by Harper and Row lists tha names of animals including the male, female, young and group names of several species. k3. Show film, "Zoo Babies."

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
. Different types of animals have different patterns of growth and development from egg to adult. Some animals go through a complete change of form or metamorphosis. Others retain a basic form but increase in size.	
l. Some animals hatch from eggs, some are born. Many kinds of animals lay eggs which contain the beginnings of a new organism and food for the early stages of the organism's growth. Eggs may differ in size, color, form, number and occurence, but all provide for new animals of their own kind.	l1. Read the following books: When an Animal Grows by Millicent Selsam What's Inside? The Story of an Egg that Hatched by May Garelick All Kinds of Babies by Millicent Selsam
	l2. Show film, "Mother Hen's Family."
	l3. Show the children a hard boiled egg that has been cut in two so that the children may see the parts: the shell, and shell lining (membrane), the white and the yolk.
	l4. Show filmstrip "Finding Out How Animal Babies Grow."
m. Animals differ in the kind and amount of care that they give their offspring. Animals feed and protect their young for various periods of time ranging from a few hours to several years. Parents care for the young animals until they are able to care for themselves. Some baby animals get milk as food from their mothers' bodies. Some baby animals eat the same kind of food as their parents do from the start.	m1. Show film "Animal Babies Grow Up."
	m2. Show filmstrip "Animal Babies."
	m3. Read the following books: The True Book of Animal Babies by Illa Podendorf. When An Animal Grows by Millicent Selsam. When Animals are Babies by Elizabeth and Charles Schwartz

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
n. All birds have two wings, two legs, and feathers covering their bodies. Different kinds of birds can be identified by general size and the shape and coloring of the body parts including the tail, back, breast, head and back, wings and legs and feet. Baby birds grow inside eggs until they are ready to hatch. Atrical birds are blind, naked and helpless when they hatch. Parents care for them until they are able to care for themselves. Precocial birds' eggs are larger and take longer to hatch. These birds are able to care for themselves as soon as they hatch.	n1. Use Judy Company See-Quee "Chicks" n2. Have an incubator in the classroom and observe chicken eggs hatching in it. n3. Break a raw egg and empty its contents into a sauce dish. Identify the white and the yolk. Point out the germ, the small light spot, on the yolk. If the egg were fertilized the germ would develop into a baby chick. The yolk and white are food for the baby chick. n4. Read the following books: The True Books of Birds We Know by Margaret Friskey Birds do the Strangest Things by Leonora Hornblow. Let's Find Out About Birds by Martha and Charles Shopp Robins by Edwin A. Mason n5. Use Hubbard Scientific Company Transparency set, Warm-Blooded Vertebrates. n6. Use Instructo Teaching Transparency, "Characteristics of Birds." n7. Show film, Birds: "How We Identify Them."
o. Most mammals bear their young alive, have hair on their bodies, are warm blooded and get food from their mothers' bodies. They are helpless for some time and must be protected. As the babymammals grow, they begin to look more like their parents and are more able to do what their parents can do. Different kinds of mammals can be identified by the general size, shape, and coloring of various parts. Differences can be discovered by examining and comparing	o1. Use Instructo Teaching Transparency, "Characteristics of Mammals." o2. Use Hubbard Transparency Set, "Warm-Blooded Vertebrates."

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
their necks, heads, tails, legs, ears and feet.	
p. Insects are egg-laying animals without backbones. They each have six legs, two feelers and three parts to their bodies including head, thorax and abdomen. A cecropia moth lays eggs in the summer which hatch and grow into caterpillars. The caterpillars spin cocoons after they have shed their skins for the fourth time. The moths emerge from the cocoons in May or June. The moth lays eggs and only lives for a few days. The metamorphasis of insects includes four stages: egg to larva (the eating stage), pupa (resting stage), to adult. Different kinds of insects can be identified by general size, shape and coloring of various parts. Insects differ in the size, shape, number and coloring of body parts including wings, legs and feelers.	p1. Place a caterpillar in a cage and watch it spin a cocoon. Place it outdoors for the winter and bring it in in the spring. p2. Make a ring from a clothes hanger and lay it on the ground. Observe, name, and count the insects in the ring each day. p3. Use Weekly Reader Picture Set "The World of Insects." p4. Read the following books: Ladybug, Ladybug, Fly Away Home by Judy Hawes. I Like Ladybugs by Gladys Conklin Fireflies in the Night by Judy Hawes Bees and Beehives by Judy Hawes Johnny and the Monarch by Margaret Friskey Sally's Caterpillar by Anne Rockwell Butterfly Time by Alice Goudey. Read Red Legs by Alice Goudey Read Tiger by Robert McClung Read We Like Bugs by Gladys Conklin Read I Like Butterflies by Gladys Conklin p5. Use Instructo Teaching Transparencies: "Life Cycle of the Butterfly" "Life Cycle of the Housefly" "Characteristics of the Housefly" "Life Cycle of the Mosquito" "Characteristics of the Mosquito" "The Ant Colony" "The Bee Hive" "Characteristics of Insects" p6. Use Hubbard Scientific Company's transparency set, "Invertebrate Animals." p7. Obtain caterpillars and watch them make cocoons and develop into butterflies or moths. p8. Use Judy Company See-quee "Butterfly".

CONCEPTS	ACTIVITIES AND RESOURCES
q. Amphibians are animals that spend part of their lives in water and part on land in a moist place. Their skins are moist and glandular. Amphibians lay jelly covered eggs singly, in clusters or in strings in still water or moist leaf mold. These eggs hatch into larvae or tadpoles which breathe by gills and spend most of their time in water. A tadpole develops into a frog or tadpole and develops lungs. It spends most of its adult life on land.	q1. Read the following books: The Toad Hunt by Ben Shecter Bufo; the Story of the Toad by Robert McClung Spotted Salamander by Robert McClung q2. Use Instructo Teaching Transparencies: "Life Cycle of the Frog" "Characteristics of Amphibians" q3. Collect frog or toad eggs and observe how they hatch. Watch the tadpoles grow into frogs or toads q4. Use Judy Company See-Quee "Frog."
r. Reptiles usually have four legs. They have four clawed toes on each foot. Their skin has bony plates or rows of horny scales. They are cold-blooded and their temperature corresponds to that of their surroundings. Reptiles hibernate from late fall to early spring under soil, rocks, or water. All reptiles have lungs and breathe air. Some reptiles are born alive and some hatch from eggs. Reptile eggs are laid on land. All reptiles care for themselves as soon as they are hatched or born.	r1. Read the following books: The Beginning Knowledge Book of Snakes by Marion Lowndes. r2. Use Instructo Teaching Transparency "Characteristics of Reptiles."
s. A fish has a backbone, gills, and fins. Some fish have lungs. Most fish have an air sac or swim bladder that helps them move up or down in the water or remain motionless in one place. Most fish have scales. Some	s1. Read the following books: Fish Do the Strangest Things by Leonora and Arthur Hornblow. Let's Find Out About Fishes by Martha and Charles Shapp. s2. Use Instructo Teaching Transparency, "Characteristics of Fish."

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
fish bear their young alive but most hatch from eggs. Fish vary in the type of care they give their young.	
t. People get many types of material for clothing from animals including wool from sheep and rabbits, leather from cattle and pigs, silk from cocoons spun by silk moth caterpillars, feathers for pillows and decorations.	t1. Children may bring in samples of things made from animal materials. Trace the material to the animal that is came from t2. Show film, "How Animals Help Us (Observing Things About Us)."
u. We get food from animals including: beef, pork, fish, turkey, lamb, milk, cheese, butter.	u1. Have children list foods eaten during the day and classify them as to whether they came from plants or animals. u2. Draw outlines of various animals from which we get food and list on them the foods that we get from them.

CONCEPTS	ACTIVITIES AND RESOURCES

CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

MATTER - CHANGES

GRADE TWO

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. Make predictions of changes that the children will observe in various substances.	a1. Discuss things that change and how they change. Teacher shows the class small jars and asks what could be put in the jars to find out if they change.
	a2. Children will probably classify objects as to how they think things will change, things that will never change and things which may or may not change. Urge the children to bring in samples of each of these and place them in Changes Jars.
b. Through a study of the material in the Changes Jars, the children will learn to make careful observations and keep accurate records.	b1. Encourage the children to observe and study all the jars each day and record the changes that occur in their own jars.
c. Some changes such as rusting, drying out, melting, water droplets, dissolving, and losses of bubbles in soda happen right away. These abrupt changes reach an end point when the substance has dissolved or crystallized fully. Some changes will take several days.	c1. Have the children list the various kinds of changes that occur in their Changes Jars such as fuzz, rusting, mold, cracks, and slime.
	c2. Determine whether the substances that took several days to change have anything in common. Discover whether anything can be done to make changes happen faster. Can water influence things to change?
	c3. Make histories or calendars to show the changes in the children's jars.
	c4. When changes occur children should be asked to report what they put in their jars, what happened and why they think it happened.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
d. Melting and freezing is a kind of change that involves a change in temperature.	dl. If a child believes a change in paraffin, candles or crayons has been caused by melting, challenge him to bring about the same change again.
e. Drying out is a kind of change that involves evaporation of water and occurs most easily in jars left open. Condensation droplets on the inside of a jar lid indicate a high moisture content. A cracked, hard, dry appearance indicates water has escaped.	el. Conduct an experiment in which one jar is covered and one is not. Determine whether the amount of heat affects the amount of evaporation.
f. Crystallizing and dissolving is a kind of change in which streaks of shiny crystals are left. When a substance dissolves, it breaks up into very small particles.	fl. Ask the children where the crystals came from, whether they can make them occur again, whether they can make them grow and whether they can make them appear and disappear again. Crystals may appear to disappear in water but in fact are only dissolving.
g. Rusting and other types of corrosion are kinds of changes that are chemical reactions between the surface of a metal and the air. Heat speeds up the chemical changes. Corrosion may become visible all over the damp surface of a metal simultaneously.	gl. Discover what metals are effected and how they are affected by rust. Can the children make some things corrode until nothing is left of them? Can they cause one end of a piece of metal to corrode while the other end does not? Determine whether a metal will rust as fast under water as it does in the air.
h. Sprouting of seeds is a kind of change.	h l. Children place brown rice, beans, lentils, corn and water in their Changes Jars and some of the seeds will sprout. Children may wish to add materials to the jars to keep them growing.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
i. Rotting is a kind of change in which mold and bacteria grow on the substance. They become visible in a single area and give off a strong odor. It takes several days for a microbial spore landing on food to germinate and multiply into a visible colony.	i1. Notice the differences among the types of rotting. Some growths are white, green, brown or black. Bacteria and yeasts look slimy and wet. Molds are fuzzy in texture.
j. Water or moisture is necessary for food to rot.	j1. Place small amounts of things that have rotted from Changes Jars on one aluminum piepan. Place items that have not rotted on another. Heat them both on hot plates. Things that are rotting will sizzle, indicating presence of water, and will turn black leaving a residue of carbon.
	j2. To illustrate the fact that animals, plants, and foods contain water, ask the children how they can find out if foods have water in them.
	j3. Children separate their jars into two groups "wet" and "dry."
	j4. Children can see the effects of water by adding it to their Changes Jars periodically.
	j5. Children may wish to try adding other liquids to Changes Jars to find out whether all liquids encourage the growth of microbes.
k. Light may affect change. Very few of the substances in the jars are sensitive to light. Molds and other microbes grow just as well in the dark. Growth of green plants is affected by light.	k1. Children try keeping some jars in the light and some in the dark, keeping other conditions the same.

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
1. Microbial growth is sensative to temperature. The germination and growth of seed plants is also affected by temperature. There is a range of temperatures in which every living thing grows.	11. Discuss why food is kept in a refrigerator to keep it from spoiling. Determine why food can be kept longer in a freezer than a refrigerator and why frozen food packages warn against refreezing defrosted food. Discuss why foods are canned at boiling temperatures.
	12. Many inorganic changes are also sensitive to temperature. This can be illustrated by comparing the rates that gelatin dessert, Epsom salt or sugar dissolve in the cold and in the classroom.
	13. Discuss the methods by which food is preserved. Ask children to bring samples of food preserved in various ways. Determine what the different methods do to the microbes. Determine what heat or cooking does to preserve food or halt decay.

E.S.S. UNIT

ENERGY - STRUCTURES

GRADE TWO

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
a. Discover what makes things stand.	a1. Discover how tall a clay tower can be made with a certain amount of clay. Add to the height of the tower by moving pieces of clay from one part of the tower to another.
b. Make predictions about the amount of material involved.	b1. Discover whether a tower could be built twice as high with twice as much plasticene.
	b2. Determine what could be done with half as much clay.
	b3. Vocabulary may be developed when children mention structures such as archs, spires, pyramid, and stalagmites that their shapes remind them of.
	b4. The children may have a contest to determine who can build the highest, widest and lowest structure with a half-pound of clay. Give two points for every "up" inch, five points for every "out" inch and one point for every "down" inch. After one-half hour the points are counted up and the winner is determined.
c. Determine how straws may be connected with one another.	c1. Experiment with such things as glue, string, wire, plasticene and common pins to discover which are the easiest and sturdiest connectors.
d. Analyze and determine what kinds of structures can be built.	d1. Determine what is the highest structure that can be built with 50 straws and 20 pins.
	d2. Determine whether a bridge can be made from one desk top to another.
e. To predict the results of a particular action and to determine which object in the structure holds it up.	e1. Discover how many straws in a structure can be cut without the structure falling down.
	e2. Build structures with various numbers of straws in which no cuts can be made.
	e3. Make two identical structures one of straws

GRADE TWO

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
	and pins, the other of spaghetti and plasticene. Determine whether they both can take the same number of cuts.
f. The strength of a material will influence how it is used. But if a material is supported adequately it can hold any weight.	f1. Put two books of the same thickness a few inches apart. Lay a bridge between them with an index card. Place pennies on the bridge until it collapses. Try it on bridge consisting to two or three index cards. Bridges may also be made between and on desks and on the floor. Determine how many washers a bridge will support and whether the locomotion where they are placed matters.
	f2. Build bridges that will hold various objects such as dictionaries. Determine how long a span can be made.
	f3. A balance may be used to discover how much weight their bridges support and how much the bridges weigh.
	f4. Tubes of newsprint may be used to build large structures.
g. Test stands which are wooden blocks with slits cut at different places along one side may be used to focus attention more clearly on some structural problems. Test stands are used for mounting, hanging and suspending cards, weights, sticks, straws and other materials.	g1. The children may experiment with the test stands varying the placement and distribution of the weights. They may try rolling, folding, taping and pleating the card placed on the test weights. An arch may be made with the card and weights.
	g2. Experiments may be done with straws and washers determining how the washers can be hung from and strung on the straw or straws. Discover where the straw breaks.
h The use of physical materials will help children to realize that only one factor should be changed at a time in an experiment.	h1. Have the children list the factors that should be controlled in using test stands and the factors that it is not necessary to control.

GRADE TWO

SKILLS AND CONCEPTS	ACTIVITIES AND RESOURCES
i. Many factors need to be taken into consideration when constructing something.	i1. Plan and construct a scale model of a town taking into consideration the many factors involved and the materials from which various structures could be built.

SIMPLE MACHINES

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. Energy is defined as the capacity for doing work, for putting matter into motion, for retarding matter in motion or for changing the direction of matter in motion.	a1. Show film "Energy Does Work." a2. Read The First Book of Energy by George Harrison, and The True Book of Energy by Illa Podendorf.
b. Force may be described as any push or pull. It may also be defined as that which produces motion or tends to produce or prevent motion. The force of gravity can be measured by weighing objects. The weight of an object is the pull of gravity upon them.	b1. Record the amount of force needed to pull a box when empty and when it has one, two or three books in it. b2. Weigh two objects and determine which is pulled more by the force of gravity.
c. A machine is any device that transfers or transforms energy or force. A machine alters the effect of energy. Machines may transform energy, transfer energy, multiply force, multiply speed or change the direction of a force.	c1. Look at pictures of various machines. Determine what each machine's name is, what it does, the force that is used to make it move and how the machine makes work easier. c2. Show film "How Machines and Tools Help Us." c3. Show filmstrip "Machines and Tools to Help us Work."
d. Work is done when resistance to movement is overcome, and force is exerted through a distance. The amount of work that is done can be measured by multiplying the force measured in pounds by the number of feet or distance that the object is moved.	d1. Match pictures of machines with the work that the machine does. d2. Determine whether it takes more energy to lift one, two, three or four boxes of sugar. d3. Fill a milk carton with one pound of sand. When a child lifts the one pound carton to the one foot mark on a yardstick, he has done one-foot pound of work. The farther an object is moved the more work has been done.

CONCEPTS	ACTIVITIES AND RESOURCES
	d4. Use Instructor Primary Science Concept Chart "Machines Help Us Work."
e. Friction is the force that resists the moving of an object over the surface of another object or through another substance. Friction results when two surfaces slide against each other. Friction between two surfaces depends upon the smoothness or roughness of surfaces and the pressure of the weight of one object upon the other. The more the friction, the greater the amount of energy is needed.	e1. Pull or push a box in which children are sitting on different types of surfaces. Compare the amounts of energy required to push the box on each surface.
	e2. Use a sprin [illegible] le to pull an open book and a closed book over a table. Determine which requires more force.
	e3. Push a book which is lying on the floor and push a book which is resting on marbles. Which goes further?
	e4. Use Instructor Primary Science Concept charts "Friction" and "Less Friction."
	e5. Read the section of the booklet "Forces and Magnets" by Willard Jacobson that tells about friction.
f. Two types of friction are sliding friction and rolling friction. More energy is needed to overcome sliding friction than rolling friction.	f1. Use a rubber band to pull an object such as a roller skate when it is on its wheels and when it is on its side. The length the rubber band is stretched indicates the amount of energy being used.
	f2. Try to push a box with nothing under it, with marbles and with round sticks.
g. Ball-bearings cause a wheel to move easier because the bearings reduce friction.	g1. Using two ridged paint cans place one can upside down on top of the other. Try turning the top can. Place marbles on the ridges of the can. Place chalk box on top of can. Try turning the can again.
	g2. Take apart a roller skate wheel and examine the ball bearings.
h. Friction between two objects may be reduced by applying liquid soap, oil or talcum powder. Friction may be increased by applying sand or salt.	h1. Have the school custodian demonstrate the oiling of a machine for the children.
	h2. Encourage the children to make lists of objects in their homes that must be oiled to reduce friction.

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
	h3. Observe how cities sand and salt their sidewalks and streets during the winter.
	h4. Slide blocks over a board. Compare the friction present when liquid soap is put on the board with that when sand is put on the board.
i. Some tasks require more energy than others. Machines make work easier but they do not reduce the total amount of work.	i1. Set up a display of pictures entitled "Things That Roll Are Easy to Push and Pull."
	i2. Try shoveling sand or snow using a shovel or hands. Decide which way is the more rapid of moving a pile of snow or sand from one place to another.
	i3. Drive three nails into three pieces of wood. Try pulling the nails out with fingers, a hammer, and pliers.
	i4. Show film "Machines That Help the Farmer."
j. Machines are used to push, pull, pry, pound, twist, and lift objects. Simple machines include the lever, wheel, inclined plane, pulley, wedge, and screw. All complex machines consist of a combination of two or more simple machines.	j1. Take a tour of the school and look for examples of simple machines.
	j2. Read What Is a Simple Machine? by Gene Darby, Simple Machines and How They Work by Elizabeth Sharp, The True Book of Tools by Jerome Leavitt and Toys by Bertha Parker.
	j3. Show films "How Machines and Tools Help Us" and "How Simple Machines Make Work Easier."
	j4. Show filmstrip "Introduction to Simple Machines."
k. A lever may be used to raise, support, or exert pressure on some object. A lever multiplies force and motion. It is a rigid bar working on a fixed point of support called the fulcrum. It is used to raise or move a weight at one point while weight or force is applied to another	k1. Pry the lid off a paint can. The edge of the can is the fulcrum.
	k2. Use a yardstick as a lever with a chalkboard eraser as the fulcrum. Place a weight on one end and lift it by pushing down the other end.
	k3. Construct a miniature seesaw lever. The children use pieces of string to measure how high a load can be lifted with the fulcrum in various positions. The lever length

CONCEPTS	ACTIVITIES AND RESOURCES
	19. Use Instructo Teaching Transparency "Wheel and Axle."
m. One wheel may turn another by means of a belt, chain, or intermeshing teeth. Gears are wheels with teeth. They can be used to change the speed or direction of a force.	m1. Collect and study toys that have gears and observe how they operate. m2. Show the children a model of a windlass. m3. Use bottle caps, a wooden block, and nails to make a model of gears. m4. Provide opportunities for children to experiment with plastic gears which turn one another. m5. Examine the chain of a bicycle to discover how a chain fits over toothed wheels. m6. A model of a belt driven machine may be made with spools, rubber bands, and a piece of wood. Spools of different sizes show how speed of force can be increased or decreased by use of wheels. The change of the direction of force through the use of wheels can be demonstrated by crossing the belt.
n. An inclined plane is a slanted surface used to move objects to a higher elevation without exerting at any given moment the degree of force required to lift it vertically. The force is active over a greater distance. Thus, ramps make it easier to raise an object to a higher point. An inclined plane or ramp distributes the force required to lift an object. Thus, heavier objects are easier to move.	n1. Try to lift a box of sand up on a chair. Measure the distance moved. Make a ramp and move the box of sand up the ramp to the chair seat. Measure and compare the distance moved as to the first time. n2. Lift a pile of books using a spring scale to measure force, with and without a ramp. n3. Draw a diagram of a stairway on the chalkboard to show it is an inclined plane and read the book Upstairs and Downstairs by Ryerson Johnson. n4. Show filmstrip "Finding Out About Simple Machines." n5. Use Instructor Primary Science Concept Chart "The Inclined Plane."

CONCEPTS	ACTIVITIES AND RESOURCES
	n6. Use Instructo Teaching Transparency "Inclined Plane."
o. A pulley is a grooved wheel that changes the direction of a force or increases the strength of a force. Objects are easier to lift with a pulley because one is pulling down instead of lifting up. Examples of pulleys are found on flagpoles, platforms, clotheslines, and venetian blinds.	o1. Try lifting a basket by placing the rope tied to the basket over the top of the door. Then, try lifting the basket when the rope is placed on a single pulley. Compare the two methods.
	o2. Use a clothes hanger, spool, and rope to make a model of a pulley.
	o3. Use Instructor Primary Science Concept Chart "The Pulley."
	o4. Use Instructo Teaching Transparency "Pulley."
p. A wedge is used to increase the strength of a force through a short distance. It consists of two or more inclined planes back to back. The length and angle of the wedge is related to the force required and the amount of work that is done. Examples of wedges are knives, axes, hatchets, needles, nails, chisels, and saws. All of these are cutting and piercing tools.	p1. Try to tear a potato apart with one's hands. Then, cut a potato in half using a knife. Which is easier?
	p2. Use Instructor Primary Science Concept Chart "The Wedge."
q. A screw is an inclined plane or ramp spiraled around an axis. Screws are used to join objects together, and to raise or lift objects. Examples of screws are nuts, bolts, spiral chutes, spiral staircases and jackscrews.	q1. A triangular piece of paper may be wrapped around a nail. This shows how a screw is constructed.
	q2. Use two screws one of which is rubbed with petroleum jelly to fasten two boards together. For which screw has the friction been reduced?
	q3. Use Instructor Primary Science Concept Chart "The Screw."

CONCEPTS	ACTIVITIES AND RESOURCES
r. Complex machines employ the principles of two or more simple machines.	r1. Determine which simple machines comprise a complex machine such as building and wrecking equipment, power shovels, bulldozers, and concrete mixers and collect pictures of them.
	r2. Visit a construction site and observe various machines at work.

ENERGY, LIGHT, AND SOUND

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. All materials are made of atoms which are joined together in groups called molecules. Molecules are in constant motion or vibration. Molecular vibration is one form of kinetic energy. This kinetic energy produces heat. The greater the kinetic energy the greater the temperature and heat of the object. The degree of kinetic energy determines whether the object is in a solid, liquid, or gaseous state.	a1. Place a drop of food coloring in a glass of water. Note how the food coloring becomes mixed with the water. a2. Place ice cubes and a thermometer in a pan, noting the temperature of the ice cubes. Heat the ice cubes stirring them with the thermometer until most of the ice is melted and note the temperature again. Note the temperature when the water begins to boil. All substances have melting and boiling points. Record all of these on a bar graph. a3. Place one cup of water in a small pan and measure the temperature. Note the time when the temperature is 20° F, 30°F, and 40°F. The higher the temperature, the more rapidly the heat is radiated away. a4. Show filmstrip "Finding Out About Heating Solids, Liquids, and Gases." a5. Read Heat All Around by Tillie S. Pine.
b. Heat may cause physical or chemical changes in material. A physical change takes place when a matter changes its form or state. The physical properties or characteristics of the material are changed but it is still the same material. A chemical change takes place when the chemical properties or characteristics of the material are changed so that a new material is formed. Heat, light, or electrical energy is	b1. Show filmstrip "Finding Out How Things Change"and "Introduction to Heat." b2. List various ways that heat changes materials and classify them as to whether they are physical or chemical changes.

CONCEPTS	ACTIVITIES AND RESOURCES
needed or given off when a chemical change takes place.	
c. Fire is a source of heat and light. Fire is used to cook food and warm oneself. Fire releases the energy from the fuel in the forms of heat and energy.	c1. List all the ways that fire is used in one's home. c2. Discuss the many ways that people of long ago used fire.
d. Heat moves in three ways. Conduction occurs when heat moves through an object such as the handle of a spoon. Convection is the transfer of heat by currents of air or water. In radiation, heat rays are constantly moving but in all directions from the radiating body.	d1. Fasten marbles to a piece of wire with wax. Hold one end of the wire in fire. As the wire heats, the marbles will fall off. d2. Heat a pan of water on a stove and notice how the handle becomes hot.
e. Materials differ in their capacity to absorb and hold heat. Heat moves through some objects more quickly than it does through others.	e1. Drop various objects made of different materials in hot water and discover whether heat moves more quickly through some materials than others. Make a chart listing objects on it through which heat moves quickly and objects through which heat does not move quickly. e2. Place paper towels around the handle of a hot pan. Do you feel the heat? e3. Place a hot pan in a cardboard box and feel if the box is warm.
f. Conditions needed to produce fire are fuel (something to burn), a source of air, and enough heat to raise the fuel to its kindling point. During combustion, a fuel is combined with oxygen. The fuel must be heated to	f1. Place a pint, quart, and gallon jar each over three of four burning candles. The flames on the candles in the jars will go out when they have used up the air in the jar. f2. Observe the various ways in which fires may be put out which include pinching, covering, smothering, and letting them use up all the fuel.

CONCEPTS	ACTIVITIES AND RESOURCES
its kindling temperature in the presence of oxygen. Heat and light are most commonly produced by combustion.	
g. Fuels may include natural gas, kerosene, coal, coke, charcoal, candle wax, paraffin and fuel oil. All fuel comes from objects that were once alive. The energy in fuel comes from the living things out of which the fuel was made.	g1. Collect pictures of fuels being used and paste them on a chart entitled "Fuels at Work." g2. Collect samples of various fuels and arrange them in a display in the classroom.
h. Fire can be dangerous.	h1. Note precautions taken in the school to prevent fires such as fireproof building materials like cement blocks and tiles, use of fire doors, enclosed stairways, doors that open outward and sprinkler systems. h2. Read the booklet *We Read About Fire and How It is Used* by Harold E. Tannenbaum. h3. Show the film "Fire Exit Drill at Our School."
i. The sun is a source of heat and light. When radiant energy from the sun strikes matter some of the energy is absorbed and changed into heat.	i1. Discuss pictures showing sun as a source of heat. i2. Take temperature readings in direct sunlight, in a shady place, at night and compare them. i3. Place one crayon or candle in a shady spot and one in a sunny spot and observe what happens. i4. Touch things that the sun is shining on. Observe how they feel when they are in the shade or in the dark. i5. Show films "Light for Beginners" and "How Sunshine Helps Us."

CONCEPTS	ACTIVITIES AND RESOURCES
j. Some of the heat of the sun may be cut off by clouds, umbrellas, buildings, clothes, and trees.	j1. Place one dish of water in the shade and another one in the sun. Measure and compare the temperatures of the water. j2. Take the children for a walk and have them list all the things that they see that are making shadows.
k. Electricity is a source of heat and light. It is used to keep us warm, to cook our food, to dry things, to iron clothes, and to heat water. When an electrical current flows through a conductor the flowing electrons expend energy in overcoming the resistance of the conductor. Therefore, the electrical energy is transformed to heat.	k1. Make a chart illustrating the different ways that we use heat made by electricity. k2. Read Rusty Rings a Bell by Franklyn Branley and Eleanor K. Vaughan. k3. Show film"Electricity for Beginners." k4. Show filmstrip "Introduction to Electricity."
l. In a powerhouse machines called generators produce electricity. A generator consists of a coil of wire that spins in a magnetic field. Water, gas, coal, and atomic fuel are the sources of power for the generators. Alternating current of a relatively low voltage is produced.	l1. Use a hand generator to light an electric light bulb. The more energy that is used the brighter the light. l2. Show filmstrip "Finding Out About Electricity."
m. Electricity is carried by wires which are held away from the poles by glass or ceramic insulators. Transformers reduce the voltage carried in the wires to the houses. Conduits in house walls carry wires to all the electrical	m1. Go outside and observe the telephone poles and telephone wires. Look at the fuse box inside the school. Examine the sockets and light switches in the classroom. m2. Show an architect's blueprint of a school so that children may see the pathways that the electric wires follow.

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
fixtures and outlets. Switches are placed in the circuits for turning electricity on and off. When the metal parts in the contact path are complete the electricity flows. When they are not it does not flow.	
n. Electric current is a continuous flow of electrons through a circuit. Wires make a complete path from the source of the electrical energy to the bulb and back to the source.	n1. Set up a circuit and do an experiment with a dry cell, attaching a wire to the terminals of the dry cell and electric lamp and socket. n2. Use Instructo Teaching Transparency "Dry Cell and Circuit."
o. The following safety rules should be followed in connection with electricity: hands should be dry when touching something electrical, don't leave lamp sockets empty or put your fingers inside them, only push plugs into electrical sockets, don't use long extension cords, don't put cords under rugs and don't use frayed or worn cord.	o1. Make drawings showing the dos and don'ts of safety with electricity. o2. Encourage the children to look for electric hazards at home and encourage them to warn their family members when they see them being careless with electrical appliances.
p. One sees by means of light reflecting from objects into our eyes. Reflected light enters the eye through the pupil, an opening to the inner eye. The pupil adjusts to the amount of light becoming larger in dim light and smaller in bright light. The light	p1. Study a large model of the eye observing its parts and determining the function of each. p2. Observe the size of one's pupil with a mirror when a bright light is shining on it and when no light is shining on it. p3. Read Read About the Eye by Kathleen Elgin.

CONCEPTS	ACTIVITIES AND RESOURCES
passes through the lens and focuses on the retina. The light sensitive nerves of the retina send messages through the optic nerve to the brain.	
q. Light travels away from a source in all directions in straight lines. Upon striking an object the light may be reflected, absorbed, and/or transmitted depending on whether the object is translucent, opaque, or transparent. An object such as stone, wood, or metal that transmits no light is opaque. Translucent objects such as glass, some plastics, and waxed paper transmit light. Transparent materials can be seen through.	q1. Use the filmstrip projector to demonstrate the differences between opaque, translucent, and transparent materials placing the materials in front of the projector light.
	q2. Inventory and classify classroom objects determining whether they reflect, transmit, or absorb.
	q3. Look at bulbs from different angles through a straw. Bend the straw and you can not see the light.
	q4. Select several objects that vary in color and texture. Observe them in bright light, dim light, or a dark closet. Describe how different qualities of light effects what one sees.
	q5. Place a hole in the top of a shoe box and a hole in one end. Tape a pencil to the other end. Shine a light through the top of the box. One can see the pencil by reflected light when one looks through the end of the box.
	q6. Show filmstrips "Introduction to Light" and "Finding Out About Light."
r. Objects either reflect or emit light. Some objects are naturally luminous. Others become luminous when they burn or are heated to incandescence.	r1. Categorize objects as to whether they give off or reflect light.
	r2. Tack several different kinds of paper to a wall (light, dark, rough shiny papers). Compare the reflections of the paper as a bright light is shone on them.
	r3. Hold a nail in the flame of a Bunsen burner until it becomes red hot.

CONCEPTS	ACTIVITIES AND RESOURCES
	r4. Examine the filament inside a clear-glass incandescent bulb.
s. Surfaces differ greatly in the amount of light they reflect and in the way they reflect it. Rays of light travel from their source in parallel rays. When rays strike a smooth shiny surface they are reflected as nearly parallel rays. The reflected light is concentrated in one direction and glare is produced. When the parallel rays of light strike a rough surface such as rippled water or rough wood, the reflected rays are scattered in many different directions. Such scattering of light is called diffusion.	s1. Place one thermometer in a shady spot, one covered with a white cloth in a sunny spot and one covered with a black cloth in a sunny spot and compare the temperatures. s2. Examine and study the way in which light passes through a prism.
t. Light travels faster through gases than liquids or solids. As it passes from one of these materials to another, the speed changes. Direction may also change as speed changes. Such bending of light is called refraction.	t1. Place one of two pencils in a glass half full of water. Place the other pencil in a glass full of water. Compare how they look. t2. Observe and compare how light passes through various other materials.
u. Sound is a form of energy that is caused by an object that is vibrating rapidly. It produces a sensation in the auditory nerves. Vibrations are transmitted through a medium by wave motion. The energy passes through the medium from particle to particle returning to the same relative position	u1. Drop a pebble in a large container of water and notice the concentric waves moving out from it. Then drop two pebbles in the water. This illustrates that many different sounds can pass through the air at one time. u2. Place some sand on the head of a drum. Watch the drum head vibrate when it is hit. u3. Read Do You Hear What I Hear? by Helen Borton and What is Sound? by Gabriel H. Reuben.

CONCEPTS	ACTIVITIES AND RESOURCES
it had before the energy was passed.	u4. Show films "Sound for Beginners" and "How Sound Helps Us." u5. Show filmstrip "Finding Out About Sound."
v. Sound passes out in all directions from an object. Sound travels through solids, liquids, or gases. Sound travels at different rates through different materials. It travels the most quickly through solids and the least quickly through gases. The velocity of sound varies with the temperature. The higher the temperature, the greater the velocity of sound.	v1. Make a tin-can telephone. v2. Bring an old hand-wound alarm clock. Child walks away from the clock until he can no longer hear it tick. Measure the child's distance from the clock. Place the clock on the chalk rail. Child put his ear on the chalk tray. Child moves away from clock until he can no longer hear the ticking. Measure and compare the two distances. v3. Blindfold child and place him in center of circle. Another child makes a sound. Blindfolded child points to direction from which sound came. v4. Place a ringing alarm clock in a metal can, paper bag, and cardboard box and compare the sounds.
w. Sound differs in its pitch. Pitch is the highness or lowness of sound. The faster a body vibrates the higher the pitch. The human ear can usually hear sounds ranging in frequency between 20 and 20,000 vibrations a second. Most sounds consist of many different frequencies. When frequencies blend, pleasing sounds are produced.	w1. Hold the string tightly and have a child pluck it with his finger. A high sound will be produced. Hold the string loosely. A low sound will be produced. The shorter the string the lower the sound. w2. Show the children a dog whistle and discuss the fact that it is at a higher pitch than we can hear. Determine what other animals can hear at a higher pitch than we can.
x. Sounds differ in their intersity. Intensity is the loudness or softness of a sound. The loudness	x1. Cover ears with hands tightly or loosely. Notice the difference in the intensity of the sound that you hear.

CONCEPTS	ACTIVITIES AND RESOURCES
or softness depends on how strongly the object is vibrating. The farther the sound travels the softer it becomes because it does not have as much energy.	x2. Show filmstrip "Introduction to Sound."
y. Sounds differ in their quality. They are produced by many different sources. Objects and phenomena can be identified by the sounds they produce because sounds differ in many ways.	y1. Make noise with objects in the classroom and have the children identify them. y2. Read booklet We Read About Sounds and How They Are Made by Harold E. Tannenbaum.
z. Sound is produced by the voice of a human as follows: a voice box or larynx is located at the top of the windpipe or trachea. Air from the lungs is blown through the glottis, a narrow slit between the vocal cords causing the vocals cords to move and a sound to be produced.	z1. Place fingers on one's voice box. Mouth a sentence. Repeat a sentence in a soft voice. Feel the vibrations of the voice box. z2. Show the children a drawing of the human body so that they might see how the air moves out of the lungs and through the windpipe to the larnyx.
aa. The outer ear of a higher organism such as man collects and concentrates sound waves. The external ear and auditory canal make up the outer ear. Sound travels through the auditory canal to the eardrum or tympanic membrane which is set in vibration. The middle ear contains three small bones: the hammer, anvil, and stirrup. Vibrations set these three small bones in motion. The	aa1. Study a large model of the human ear identifying and determining the function of each part. aa2. Point out that some lower animals receive sounds with organs located on other parts of their bodies. Note where these organs are located on the animal. aa3. Read Read About the Ear by Kathleen Elgin.

CONCEPTS	ACTIVITIES AND RESOURCES
fluids in the cochlea of the inner ear are also put in motion. The small hair cells send the electrical impulses to the brain where the sounds are interpreted.	
bb. Sound waves can be concentrated in one direction and amplified by a device such as a megaphone.	bb1. Let the children experiment with a megaphone to discover how it concentrates and amplifies sound. bb2. Draw the children's attention to various horns and musical instruments that have parts which amplify and concentrate the sound in a particular direction.
cc. Sound may be reflected when it hits something and an echo is heard.	cc1. Talk into a can with both ends open. Talk into a can with one end open. Can an echo be heard? cc2. Ask the children to tell about experiences that they have had in hearing echoes.

CONCEPTS	ACTIVITIES AND RESOURCES

CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

TANGRAMS

GRADE TWO

CONCEPTS	ACTIVITIES AND RESOURCES
a. A tangram consists of a square divided into seven geometric shapes: two large triangles, a medium triangle, two small triangles, a square, and a rhomboid. These pieces have basic relationships which the children will learn to recognize.	a1. The equipment includes a box of four plastic tangrams, two white and two black. Each package contains 121 patterns which children can match by placing the tangram pieces either on or alongside the cards. Set I has 2 patterns involving two pieces, 6 patterns requiring three pieces, and 9 patterns requiring four pieces. Set II has 27 patterns all of which require five pieces. Set III has 77 patterns involving all seven pieces. The children can use the pattern card as a map and consult it as they build a matching pattern alongside. The child may also work the pattern right on the card.
	a2. Children may create their own tangram patterns. They may invent pictorial designs. Classmates may try to match other children's tangram patterns. They may make copies of their patterns.
b. To develop dexterity and facility in manipulating the pieces moving from fingertip solutions, to visual solutions, to analytical solutions of problems.	b1. Try a pattern by allowing just one trial placement of each piece. b2. Try to draw a diagram of the solution without touching pieces or looking at them.
c. Area may be investigated. The area of any one piece can be expressed in terms of any other piece.	c1. Discover how many squares can be made from various numbers of pieces and how large they are.
d. Different kinds of solutions are possible for the same problem.	d1. Encourage children to keep drawings of their solutions and compare them with other solutions of the same problems.

SOLAR SYSTEM

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Our solar system is made up of the sun, nine planets, and their moons.	a1. Show filmstrip, "The Solar System."
b. The planets and moons receive heat and light as they move around the sun.	b1. Show filmstrip, "The Solar System."
c. Four planets are larger then the earth and four are smaller.	c1. Have each child hold a small disc (penny) and a large disc (jar lid) at arm's length. Have each pupil close one eye and bring the small disc in close to the eye. Let the children tell you that the small disc now "seems" larger than the large disc.
d. The brightness of the sun and sky keeps us from seeing the stars in the daytime.	d1. Darken the room and notice how bright a flashlight appears. Then open the shades and turn on the room lights. Compare the brightness of the flashlight.
e. A constellation is a group of stars with its own shape.	e1. Observe a sky chart showing the constellations and their shapes.
f. The sun is the central body in the solar system.	f1. Show filmstrip, "The Sun."
g. The planets travel around the sun in elliptical orbits.	g1. Draw a diagram that shows nearly circular orbits of the planets.
h. Solar radiation is received by all the planets in the solar system; the intensity of solar radiation decreases as the distance from the sun increases.	h1. Hold your hand close to a light bulb. How does it feel? How does it feel when you move it away?

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
i. The planets are held in their orbits by gravitational attraction between them and the sun.	i1. See ill. Science 3, T.E. Silver Burdett, p. 13.
j. Mercury and Venus are the planets closest to the sun.	j-p Observe a large chart of the planets drawn to scale.
k. Because of their nearness to the sun, Mercury and Venus have high surface temperatures.	k1. Refer to activity h.
l. The orbits of Mercury and Venus are smaller than those of any other planet.	l1. Measure the circumference of a tree one foot out and three feet out to show the difference in distance traveled.
m. Mercury and Venus are visible from the earth because of the sunlight they reflect.	m1. See how many children can locate Mercury and Venus at night.
n. Earth and Mars are probably the only two planets in the solar system on which conditions are suitable for life to exist.	n1. Study pictures of Mars to observe the color of the planet which leads scientists to believe life could exist. n2. Provide trade books for the class that contain information on Mars. Then have the children make travel posters that describe the "point of interest" on the planet.
o. The four most distant planets are sometimes called the major planets.	a-p As a culminating activity: Have the children make paper models of the planets in the solar system. Color the models and give each one appropriate identifying characteristics.
p. With the exception of Pluto, the distant planets are hundreds of times larger than the earth.	

MOON

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. The moon is reflecting the light of the sun.	a-y Use E.S.S. Unit, "Where is the Moon?"
b. One side of the moon is always lit.	b1. Shine a flashlight (sun) on a round object (moon).
c. The moon travels in a path around the earth in about a month.	c-f Go outdoors. Draw a circle on the ground. Have someone stand in the center of the circle. This person can be earth. Ask a student to be the moon. This person should walk slowly around the circle. His path is the orbit. Have the earth-person throw a ball to the moon-person. How does the earth-person have to aim?
d. The path is called its orbit.	
e. During each revolution about the earth, the moon rotates once.	
f. The same side of the moon always faces the earth.	f1. Use a desk to represent the earth and a student to represent the moon. Have the student move around the desk always facing it. What direction does he face as he starts around the desk? What direction does he face as he goes around the desk?
g. The moon revolves about the sun.	
h. There is no air or water on the moon.	h-i Study pictures of the moon.
i. There are no plants or animals on the moon.	
j. It would take 50 moons to make a ball as big as the earth.	j1. Make 51 balls of clay the same size. Now use 50 of the balls to make one large ball. Compare the size of the large ball with the size of the small ball.

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
k. The moon is the earth's nearest neighbor in space.	k-1 Have the children observe the moon through strong binoculars or a telescope. Have them discuss what they observed.
l. The moon is about 240,000 miles from the earth.	
m. Some of the small craters on the moon are believed to have been caused by volcanic eruptions.	
n. The large craters are believed to have been caused by meteorites.	n1. Put some smoothed sand in a box and drop a marble in it to show how meteorites might have caused the craters.
o. The large, dark areas of the moon's surface are believed to be huge lava plains.	o-q Prepare a report to tell what the moon is like.
p. The moon has mountains, plains, and craters.	p-q Make a model of the moon showing its mountains, craters, and plains. See ill. of moon in text, Science 3, Laidlaw Science Series, 1966,p. 141.
q. Surface features include comparatively smooth plains misnamed "seas," cracks about half a mile in width called rills, and bright streaks five or ten miles wide and up to 1500 miles long called rays.	
r. As the moon revolves around the earth, different amounts of the lighted half of the moon can be seen from the earth. Sometimes we can see all the lit-up side; at other times we see only a part of it or none at all.	r1. Use a planetarium to determine the rotation and revolution of the moon.

CONCEPTS	ACTIVITIES AND RESOURCES
s. These different shapes are called phases.	
t. When the moon is between the earth and the sun the entire lighted hemisphere faces the sun and the dark side faces the earth. In such a position the moon is described as the "new moon."	tl. See ill. in text; Science Far and Near, Heath, 1968, p. 212. t-y Draw pictures of the moon in its different phases and place them on a bulletin board.
u. During the evening following the new moon, the "crescent moon" can be seen in the west after sundown.	
v. The crescent enlarges nightly to become the "quarter moon."	
w. Halfway between the quarter moon and full moon is the "gibbous phase."	
x. The "full moon" is seen as a rounded light.	
y. After the full moon, the moon "wanes" from full to gibbous, to "last quarter," and back to new moon again.	yl. Have the students obtain a calendar which shows the phases of the moon. Note how long it takes the moon to pass from new moon to full moon and then back to new moon again. Determine the cycle for the entire year, keeping track of the number of days between each new moon and the next, and determine whether this period averages 29½ days. Enrichment: Find out which of the space

CONCEPTS	ACTIVITIES AND RESOURCES
	projects are being carried on to learn more about the moon. Find out what these projects hope to do.

SOIL

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. The surface of the earth is made of bedrock.	a1. See filmstrip "What Is the Earth?" Benefic Press; "What Is the Earth Made Of?" Popular Science, McGraw-Hill Book Company, Inc.
b. Bedrock is changed to rock and soil by temperature changes and by the actions of water, plants, and animals.	b1. Examine some rock and soil to determine what condition it is in. Put some soil in a jar of water. Shake it up. Then let it stand for a while. Slowly pour off the water into a bowl. Observe the water in the bowl. Does it look different? Now take some soil from the bottom of the jar. Rub it between your fingers. How does it feel now? Compare size and color of the soil. What changes have taken place?
c. There is bedrock under the land and sea.	
d. Some of the earth's surface is rocky; other parts are covered with soil or water.	d1. Study different pictures of the earth's surface noticing the different types of surfaces: rocky, sandy, smooth, etc.
e. Soil contains tiny bits of rock.	e1. Examine some soil under the magnifying lens and notice the tiny rocks.
	e2. Spread half a teaspoon of sand on graph paper with small squares. Are the little grains of sand all the same shape and size? First guess, then count the number of grains on one square.
f. Rock is cracked and split by contraction and expansion caused by temperature changes.	f1. Put a cold drinking glass in a pie tin. Pour in some hot water. Heat up a drinking glass in some water. Place it in a pie tin. Then pour some cold water into it. The glass should crack in both cases.
	f2. Screw the cover on an empty jar so tightly that it is too hard for you to open. Then run some hot water over the cover only. Dry

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
	it. Now try to open it. The heat of the hot water made the cover bigger.
	f3. Freeze a jar that has been completely filled with water and capped. Put the jar in a bag while freezing.
g. Running water brings about changes in rocks. 1. Moving water cuts into large rocks when small rocks, pebbles, and sand work at it like a saw.	g1. Study some maps that show where deltas have been formed. Discuss where the soil came from.
	g2. Study pictures of the Grand Canyon and notice how the running water has, over thousands of years, cut through the rock.
h. Water in cracks of rocks expands when it freezes, thereby splitting the rocks.	h1. Fill an empty ice tray with water. Fill it to the top. Let the water freeze. Now look at it. The ice is heaped higher than the top of the tray. When water changes to ice, it expands and takes up more room.
i. Some plants soften and crumble rocks as they grow on them.	i1. Observe lichen-covered rocks on a field trip or in the classroom. Notice how the rocks are discolored and that the rock has been broken down into many tiny pieces.
	i2. Take a field trip to look for large rocks with cracks in them. Are there any plants growing in the cracks?
j. The earth's surface is always changing as rocks are changed to soil. Many different kinds of soil are formed as different kinds of rocks are changed to soil.	j1. Bring in soil from different places. Try to get soil from each of these: a farm, a woods, the bank of a brook or river, a place where a house or road is being built. Put a cupful of each kind of soil into jars. Add water until each jar is almost full. Put covers on tightly and shake the jars. Let the jars stand until the water is almost clear. Observe the soil. Do you notice any different layers in the soil? Is anything floating?
k. In the beginning our planet had no soil. Now most of the land, except in the far north	k1. Observe some pictures of how the earth might have looked in its early formative years.

CONCEPTS	ACTIVITIES AND RESOURCES
and far south, are now covered with a layer of soil.	
l. Soil comes from two main sources: from the rocky crust of the earth and from living things.	l1. See the films: "What Is Soil?", Encyclopedia Britannica Films, "Your Friend, the Soil," Encyclopedia Britannica Films.
m. People are dependent on soil and water for their food.	m1. For a class exhibit, encourage children to bring in clean, empty food containers. A small committee might be appointed to group the containers according to some plan, as: meat foods, dairy foods, fruits and vegetables, and cereal foods. In a discussion period, children might then be helped to trace each kind of food back to its dependence on soil and water.
	m2. If you are in a rural area or the children know of someone who lives on a farm, they can tell of foods grown and the kinds of animals that are raised. What do the animals eat? What foods (plant or animal) come from the farm where they live?
n. Soil is made up of more than "dirt"-- it is made up of a variety of substances from living (organic) and non-living (inorganic) materials.	n1. Spread out some soil and let the children examine the grains carefully. They will see that the tiny grains look like sharp bits of rock and things that were once living. Look for sand and clay. Notice if there are any plant materials in the soil.
	n2. See filmstrip, "How Soil is Formed," McGraw-Hill Publishing Co., Text Film Dept. 330 W. 42nd St. New York, N.Y. 10036.
o. Matter in soil is found in three states; solid, liquid and gas.	o1. Put some garden soil in a cooking pot. Then cover the pot with a lid or piece of foil. Put the pot on a source of heat and watch what happens. Do you see drops of water on the sides and top of the pot?
	o2. Put some garden soil into a jar. Pour some water slowly over the soil to fill the jar. Stir the mixture and let it stand. Do you

CONCEPTS	ACTIVITIES AND RESOURCES
	see bubbles rising from the soil? Air is trapped in the soil which is gas.
	o3. Pour a mixture of soil and water through a paper filter. A cloudy, liquid goes through the filter. The soil remains in the filter. Pour the liquid from the jar into a pie tin. Let the liquid evaporate. What is left are minerals or solids from the soil.
p. The water-holding capacities of various soils are different.	p1. Take three coffee cans and hammer six holes in the bottom of them. Make the holes about halfway between the middle and the edge. Stand each coffee can on top of a jar. Put exactly one cupful of sand in the first can, a cupful of soil in the second can, and a cupful of humus soil into the third can. Add exactly one cupful of water to each can. Pour in the water slowly. Observe.
q. Living things need a suitable environment for growth.	q1. Fill one flowerpot with clear, white sand and the other with fine garden soil. Water both pots. Plant four seeds in each pot. Put the pots in a warm, sunny place. Observe the growth of both plants and make comparisons.
	a-q Enrichment Activities 1. Field trip - If there is a building excavation being dug or a road being cut through a hill, try to take the children to see the revealed cross--section of layers of Earth's crust. Look for the layers of soil on top of layers of solid rock. 2. Picture Book - Let children use large sheets of paper for original pictures to illustrate things we use that come (via green plants) from soil. Captions or original stories might be added to the pictures. Fasten the pages together, decide on a title, and choose someone to make a cover. Make the book available for browsing.

CONCEPTS	ACTIVITIES AND RESOURCES
	3. Write a short story to explain why soil is Earth's greatest treasurer. 4. Allow the children to read directions on the packages of certain vegetables such as radishes and try growing their own.

ROCKS

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. The three kinds of rocks are - igneous, sedimentary, and metamorphic rocks.	a-d Collect samples of different kinds of rocks in your community. Good sources are river banks, rock piles of farmers, road cuts, excavation of buildings, beaches, gravel pits and quarries. After the rocks have been collected, divide them into groups according to similarities of color, shape, material and other characteristics. Smooth, round rocks have most likely been acted upon by running water. Flat rocks are usually pieces of sedimentary rock.
b. Sedimentary rocks, as the most common type on the earth's surface, indicate the vast areas that were once lakes, rivers, and ocean bottoms.	
c. Rocks differ in many ways, such as hardness, color and texture.	c1. Classify rocks according to hardness. Bring some rocks to school. Select any two of them and try to scratch one rock with the other. The one that makes the scratch is harder. The softer rock will not scratch the harder rock. Try scratching other pairs of rocks. Geologists test rocks for hardness. The numbers are called a hardness scale. The softest rocks have a hardness of 1. The hardest rock (diamond) has a hardness of 10. After you have tried scratching all your rocks, put them in order according to hardness.
d. Rocks can also be identified and grouped according to the way they were made and where they come from.	
e. Sandstone is a rock which is formed by the action of wind, water,	e1. Put some sand in a tin can from which the ends have been removed. Replace the ends to enclose the sand in the can. Squeeze

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
and ice on older rocks which become stuck together while under shallow seas.	the sand with a C clamp. Observe the rock like appearance of the compacted sand.
	e2. Examine pictures of the Pueblo houses and develop the possibility that this home was made of sandstone.
	e3. Look for buildings in the community that have been built of sandstone. (Old buildings in downtown St. Paul or Mpls.)
f. Sandstone, a sedimentary rock, varies in color according to the chemical material which holds the sand particles together.	
g. Clay is a sedimentary material which may or may not become rock.	g1. Experiment with clay. Obtain a lump of dry clay. Put the clay in a bowl of water. Leave it there for a while and then stir it. What happens to the clay? What happens to the water?
	g2. Do the same experiment as described in g1. Use a broken clay flowerpot or broken clay dish.
	g3. Try firing some clay to see the effect heat has on clay.
h. Sedimentary materials are emptied or deposited in the sea by rivers.	h1. Show some piles of sediments studied so far. Place them in a large jar of water. Develop the idea that streams also carry large pebbles. Add some pebbles to the jar and mix or shake the contents as a stream might. Pour the contents of the jar out on an inclined tray which empties into a clear glass bowl. Observe that the pebbles fell immediately onto the tray, while the water carried the clay particles and sand farther out.
i. Large particles of sediment in the form of pebbles become stuck together to form a rock called puddingstone.	i1. See if any of the children have found some puddingstone.

CONCEPTS	ACTIVITIES AND RESOURCES
j. Limestone is a sedimentary rock that varies in color, texture, and origin. The origin is mainly plant or animal marine life.	j1. Test for limestone. Scratch some rocks. Pour a few drops of vinegar or lemon juice on the scratches. Do any of them bubble like soda water? All limestone bubbles when tested this way.
k. Fossils are the remains or prints of plant or animal life found naturally buried in rock.	k1. Go fossil hunting. The banks of the Mississippi River are a good place. Examine the specimens carefully and consult a good handbook on fossils to identify them.
	k2. Have a fossil exhibit. Show actual fossils, with identification labels or cards, accompanied by drawings or pictures of what the living plants or animals actually looked like.
	k3. Make your own fossils with leaves and plaster of Paris.
	k4. Refer to Science for the Elementary School, Edward Victor, Macmillan Co., 1965 p. 333.
	k5. See filmstrip, "What is a Rock?"

OCEANOGRAPHY

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. The ocean is a large part of the earth's surface and covers over two-thirds of it.	a1. Make a paper boat. Put it on the globe near land. Sail it away from the land. Look for the end of the ocean. Look for a place where you cannot sail around the land to another part of the ocean. Can you find such a place?
	a2. Get a good picture of the ocean. Have children who have visited the ocean explain their experiences, explaining and telling about such things as the sound of the surf, the smell of ocean air, fish and shell animals, and the seeming endlessness of the ocean.
	a3. On a globe or a world map, point out the Pacific Ocean, Atlantic Ocean, Indian Ocean, Arctic Ocean, and Antarctic Ocean.
	a4. Through charts and pictures, show the children what we know about the ocean's bottom, its depth, and the fact that all of the oceans of the world are really part of one big ocean.
b. Rivers carry salt and other minerals into the ocean, thus making the ocean saltier than the rivers that flow into it.	b1. Have the children list all the minerals they know about, and emphasize the fact that salt is a mineral. Examine an amount of salt.
	b2. To develop the concept that when rain falls on rocks and soil, it picks up and carries away tiny bits of some minerals, do the following: Cut off the tops of two milk cartons. With a large needle, put a few holes in the bottom of each. Put a handful of clean washed sand in each. Then mix a spoonful of salt with the sand in one of the cartons. Put both cartons on blocks of wood. Put a small cup under each carton. Pour a half cupful of water into each carton. Let the water

CONCEPTS	ACTIVITIES AND RESOURCES
	trickle through the cartons into the cups. Take a tiny taste of the water in each cup. Children discover the salt went into the water. The salt dissolved in the water, but the sand did not.
	b3. On a physical map of the United States, point out the large rivers that flow into the oceans and into the Gulf of Mexico. Note that the water in the small feeding streams is fresh water.
	b4. Pour a cupful of water into a closed jar and another cupful into an open bowl. Dissolve ½ teaspoonful of salt in each. Set both containers in a warm, sunny place for two days or more. Then taste the water from each container. The water in the open bowl will be more salty. When water evaporates in the ocean the salt remains.
c. The ocean contains many valuable minerals, particularly salt.	c1. Discuss some uses of salt. Through the process of evaporation, explain to the children that it would be possible to obtain enough salt from ocean water for use in large quantities.
	c2. On an outline map of the United States, show the states which produce salt. Find out where these industries are and how the salt is obtained.
	c3. Have the children find out and discuss other ways of getting salt. (mines and wells)
d. Oceanographers are scientists who study the ocean.	d1. Make a report on the jobs of oceanographers.
e. Tiny plants called "diatoms" and tiny animals called "copepods" are basic for life to continue under the ocean. Sea animals feed on these.	e1. Show the children some pictures and charts of the many kinds of simple green plants in the water, known as diatoms.
	e2. Make a scrapbook of the various products which are made from deposits of dead diatoms as their shells pile up on the bottom

CONCEPTS	ACTIVITIES AND RESOURCES
	of the ocean. Pictures may be cut from magazines of such things as soaps, tooth powder, polishes, and abrasives.
	e3. Explain how the shells of diatoms make up the most important part of the floating mass of living things, called "plankton." Plankton is the principal food of many marine animals.
f. Tiny plants called algae supply most of the food for small sea animals.	f1. If there is an aquarium in the school, place under a microscope some of the green "scum" which forms on the walls of the aquarium. The class will see that this "scum" is really made up of tiny green plants (algae). Point out that the tiny plants in the aquarium are similar to those found in the ocean.
g. Bigger animals eat tiny animals; big fish eat little fish.	g1. Discuss the food chains of the sea animals. Have pictures to illustrate.
h. People eat both plants and animals from the ocean.	h1. If the teacher so desires, he could arrange for a class to visit a fish market. The children could identify the various sea fish, shellfish, shrimp, clams, oysters, mackerel, or lobsters. h2. If possible, get a specimen of a salmon. Trace the life cycle. h3. Try to get a giant kelp, which is a type of seaweed. Emphasize the fact that it contains large amounts of iodine and algin. Algin is used in ice cream, salad dressing, and certain drugs.
i. Some mammals have adaptions for life in the ocean and provide man with many valuable products.	i1. Through pictures, books, and collections, develop the idea that the animals of the sea are many and varied. The children can make oral or written reports. i2. Keep a running list on the chalkboard of the names of all the kinds of animals the children discover by any and all means. Have the children illustrate the various

CONCEPTS	ACTIVITIES AND RESOURCES
	forms of ocean life.
	13. Make a study of the whale. Learn about the history of the whale's use to man. Develop the understanding that people who live in cold places need fat in their food because fat is a heat-making food.
	14. Make a chart to show all the things we get from sea animals and plants.

E.S.S. UNIT

ICE CUBES

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Ice melts at different rates according to variables such as surrounding temperature, exposed surface area, substance in which it might be placed and volume.	a-h See Teacher's Guide, Ice Cubes, McGraw--Hill Book Company, 1969.
b. Heat is required to melt ice.	
c. Heating and cooling of a certain liquid is directly related to its volume and heat content.	
d. Insulation prevents rapid transmission of heat between an object and the surrounding air.	
e. The insulating quality of a substance is determined by its ability to conduct heat.	
f. Temperature is measured through the use of a thermometer.	
g. The freezing point of a substance is determined by its composition.	
h. The density of substances differs.	

WEATHER AND WATER

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Special types of instruments are used in collecting information about the weather such as thermometers, barometers, weather vanes, anemometers, psychrometers, and rain gauges.	a1. Bring in as many types of weather instruments as pobbible to display. Discuss their uses.
	a2. Making a thermometer. Pour water that has been colored dark red with food coloring into a Pyrex flask until the flask is almost full. Insert a long glass or plastic tube in a one-hole rubber stopper and fit the stopper tightly into the mouth of the flask. The amount of water in the flask will have to be adjusted so that, when the stopper is inserted, the colored water will rise about one third to one half of the distance of the part of the tube above the stopper. Make two slits in an unlined index card and slide the card over the tube. Mark the original height of the water in the tube. Observe the rise and fall of the water as the temperature changes and record them each day at the same time.
	a3. Making a barometer. Obtain a milk bottle or a glass jar with a medium to narrow mouth. Cut out the dome-shaped end of a rubber balloon and stretch the rubber tightly across the mouth of the balloon, fastening the rubber sheet securely with a rubber band. Flatten both ends of a soda straw and cut one of the ends to a sharp point. Place rubber cement or glue on the flattened end of the straw and attach the flattened end to the middle of the rubber sheet. Cut a tiny piece of wood from a match and glue it at the edge of the rubber sheet so that the straw rests on top of the wood. When the air pressure in the room increases, the rubber sheet is pushed down, making the straw move up. When the air pressure decreases, the greater the air pressure inside the bottle now pushing the rubber sheet up, makes the straw move down. A cardboard scale will help the children see the changes.

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
	a4. Make a anemometer and a weather vane. See Science for the Elementary School, Edward Victor, 1965, pp. 390-391.
b. Weather in the United States of America generally moves from west to east.	b1. Collect weather information by cutting daily weather maps from the newspaper. Post these so all the children can study them.
c. There are three main kinds of clouds: cirrus clouds that are shaped like a feather, stratus clouds that form a layer across the sky, and cumulus clouds that are thick and puffy with flat bottoms.	c1. Plan to observe the sky each morning, afternoon, and evening at the same time each day. Make observations about the clouds. How much of the sky is covered with clouds? What do the clouds look like?
	c2. Keep a picture record of the clouds observed each day. Include the date, weather conditions, and type of clouds.
	c3. Have each child draw an imaginary circle around a certain section of the sky. Let each child draw on paper that part of the sky. Compare their drawings to see if all the clouds are alike.
	c4. Obtain a set of the SVE Picture-Story, Study Prints Set SP-115, "Familiar Cloud Forms."
	c5. Invite a meteorologist to speak to the class on clouds and weather.
	c6. See filmstrips, "World of Clouds, Thunder, and Lightning", "Weathermen at Work", "Changing the Weather" and "Weather Folklore."
d. Water is continually on the move, leaving the earth through evaporation and returning to the earth in some form of precipitation, such as rain. This is called the water cycle.	d1. Put three inches of water in each of two glasses. Put both glasses in a sunny, warm place. Cover one glass. Measure the water in each glass every day. Where is the water going in the uncovered glass?
	d2. Let the children plan a bulletin board illustrating the water cycle. Have the children tell of the water cycle in their own words.

CONCEPTS	ACTIVITIES AND RESOURCES
	d3. Use a transparency overlay to better show the water cycle.
e. Water vapor, carried up by air as it evaporates, may form clouds or fog.	e1. Demonstrate how a cloud is formed, Fill a bottle with hot water. After several minutes pour out most of the hot water except a small amount at the bottom of the bottle Place a burning soda straw into the bottle and wait until it goes out and begins to smoke. Pull the straw out and place an icecube on the opening of the bottle. What happens? What part did the hot water and smoke play to help the cloud form?
f. Water vapor in a cloud clings in tiny particles to specks of dust as it cools.	f1. Refer to: *Science for the Elementary School*, Edward Victor, 1965. pp. 385-386.
g. Water vapor eventually changes to water (condenses) as the amount of moisture increases and cools, resulting in precipitation in the form of rain, hail, sleet, or snow.	g1. Put a glass of cool water on a table. Put some ice in the glass. Observe what happens to the outside of the glass as the air is cooled around the glass.
	g2. Observe water boiling in a teakettle on a hot plate. Observe the cloud above the spout and the invisible space between the spout and the cloud.
h. When the temperature is below freezing, the water vapor becomes frost.	h1. Make frost, snow, sleet, and glaze. Obtain a tall can and fill it with alternating layers of cracked ice and table salt. Make each ice layer twice as thick as the salt layer. Pack the mixture of ice and salt down firmly. Put two or three drops of water in the center of an index card and place the tin can directly on top of the water. Some dew may form on the sides of the can and then freeze, but frost will also form as the temperature of the air beside the can falls to below freezing. After the sides of the can are well covered with frost remove the can from the index card. The drops of water will have frozen into ice.

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
i. Heat makes water evaporate more quickly.	i1. Put ten drops of water in each of two pie tins that are the same size. Put one tin on the window sill where the sun can shine on it. Put the other tin in the coolest place in the classroom. The water will evaporate more quickly in the heated tin because the water molecules move faster, and thus more molecules can leave the water at one time.
j. Cooling causes water to condense more rapidly.	j1. Add water to a shiny tin can until the can is half filled. Then add ice cubes and stir. Soon a thin film of tiny droplets of water will form on the sides of the can, as the air containing water vapor is cooled and the molecules of water vapor move more slowly and come close enough together to become water again.
k. Weather scientists use a rain gauge that can measure the amount of rain that has fallen.	k1. Find a tall glass jar with straight sides. Put the jar where rain will fall into it. The next time it rains measure the amount of water in the jar.
l. Some of the moisture that falls on the land soaks into the ground and forms underground water, most of which returns to the sea by flowing into small streams and subsequently into large rivers.	l1. Draw a diagram on the chalkboard showing the path water takes as it lands on earth and then continues along on its way to the sea.
m. Water can be stored for later use, or it can flow into irrigation ditches and provide moisture for plants.	m1. Have children describe where they have noted water being stored for future use. How did the water get there?
n. Irrigation helps crops to grow on land that would otherwise be barren.	n1. Study some pictures of barren deserts that now are productive because of the water that has been brought there.

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
o. Water is transported from the principal source through large pipes called mains, and then through smaller pipes to most of our homes.	o1. Visit the water reservoir in your community to show the children how the water is stored up.
	o2. Invite a city planner to come and talk to the class on the water system needed to supply a city.
	o3. Plan a trip to a place where a new house is being built. Find out about the water supply for the house.
p. Pumps force the water through the pipes.	p1. Trace the route of the water from its source to your home. Observe the need for a pump. Visit a pumping station.
q. All living things have water as a part of them.	q1. Try some experiments in finding out how much water is contained in different living thihgs. Example: Take a tomato and weigh it. Then squeeze out as much water as possible. Allow what is left over to evaporate. Weigh the remaining tomato. Compare the weight before and after.
r. All living things need water	r1. Play a guessing game with the children. Say "I am thinking of something that you have often used. It is found on many street corners, in the halls of schools, and in department stores. You are more likely to use it when it is hot outside than when it is cool. What is it?" (Drinking fountain) Discuss why so many places have drinking fountains.
s. Animals obtain water from the liquid they drink and the foods they eat.	s1. Have the children observe how animals in their community take in water. (Dogs and cats take up water with their tongues; horses purse their lips and suck in the water; birds scoop up the water and tilt their heads back to swallow it.) Encourage the children to report their findings.
t. Not all living things need the same amount of water.	t1. Obtain some gerbils and study the eating habits of them. Notice that as a desert animal it does not take in nor give off very much water compared to other types of animals.

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
u. Green land plants take in water mainly through their roots.	u1. Carefully cut the stem of a white carnation plant. Place the stem of the flower in a glass of colored water. Leave it there for a day. Observe what happens.

AIR

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Air is a colorless, odorless mixture of gasses. By volume, it is approximately 78% nitrogen, 21% oxygen, .03% carbon dioxide, and small quantities of hydrogen, argon, helium, radon, krypton, xenon, and neon.	a1. Place an empty glass on your desk. Ask the children if the glass is full or empty.
	a2. Draw a diagram of the nitrogen cycle. Trace the conversion of free nitrogen in the air into nitrogen materials that plants and animals can use, and then trace the conversion of the different nitrogen materials back into free nitrogen again.
b. Air occupies space and is all around you. We live in an ocean of air which extends above the earth approximately 200 miles.	b1. Have the children observe their surroundings to find clues that air is all around them. Examples: fish emit some air bubbles, a gopher which lives under the ground has air to breathe, an airplane flies through a real substance, birds soar high in the sky, and moving air holds a kite aloft.
	b2. Put a handkerchief into the bottom of a glass. Now put the glass mouth down into an aquarium full of water. Push the glass slowly into the water. Remove the glass from the water. Take out the handkerchief. The handkerchief is dry.
	b3. Put a glass into the aquarium. Let it fill with water. Hold it mouth down. Push a second glass into the water, mouth down. Let no water get into this glass. Now, raise the water-filled glass above the second glass. Tilt the second glass. Air bubbles escape from the tilted glass. The air bubbles go into the water-filled glass. The air will push the water out of this glass. Pour the air back into the second glass. Keep pouring.
c. Air can be compressed.	c1. Make a hole in the cap of a milk bottle. Punch a hole with a pencil. Put a small funnel into the hole. Be sure the funnel fits tightly. Seal it to the hole with clay.

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
	Now try to pour water into the bottle. Does the water go into the bottle? (A little may run in.) Why not?
d. Air presses equally in all directions.	d1. Fill a glass with water. Put a piece of cardboard over the top of the glass. Hold the card in place with one hand. Now turn the glass upside down. Hold your hand against the card as you do this. Now take your hand away. What happens?
	d2. Experiment with different amounts of water in the glass.
	d3. Wet the mouth of a plumber's force cup. Press it against the chalkboard. Try pulling the force cup away from the chalkboard. Now throw some rubber darts at the chalkboard. You will hear a loud smack. What is happening? Why do the darts stick?
	d4. Drill a small hole in the plumber's force cup. Now try to make it stick to the chalkboard. What happens?
	d5. Make a siphon. Siphon some water out of a jar. How does air help a siphon to work?
e. Air expands as it is heated and contracts as it is cooled.	e1. Develop the meaning of expand and contract. Ask children to suggest ways to explain its meaning. List the suggestions on the chalkboard.
	e2. Place a balloon over a baby bottle. Heat the baby bottle in a pan of water over a hot plate. What happens to the balloon?
	e3. Take the balloon which was heated. The balloon is big. The air in it has expanded. Now cool the baby bottle. Put the bottle with the balloon into a pan of ice cubes. What happens to the balloon?
	e4. (Teacher demonstration) Set a candle in a baking dish. Heat the end of the candle to make it stand. Pour about one inch of water

CONCEPTS	ACTIVITIES AND RESOURCES
	into the dish. Color the water. Light the candle. Place the jar over the candle. What happens? The candle warmed the air, which expanded. As it expanded, the air left the jar. The air made bubbles in the water. The water in the dish kept more air from getting into the jar. The candle went out.
	e5. Do the old egg in the bottle experiment. Remove the shell from the hard-boiled egg. Roll a paper towel into a stick. Light the towel with a match. Drop the burning towel into the milk bottle. Quickly place the small end of the egg on the mouth of the bottle. What happens? Air expands. Air pressure becomes less in the bottle than outside. The air on the outside pushes the egg into the bottle. Try getting the egg out. Let children experiment. Blow air into the bottle with the egg at the mouth of the bottle.
	e6. The teacher drops a piece of burning paper into a milk bottle. She lets the paper burn almost completely. Then she places a balloon over the top of the milk bottle. The balloon is partly blown up. Air from the outside pushes the balloon into the bottle. Repeat the experiment, but this time put the balloon over the bottle right away.
f. Air has weight.	f1. Drill a hole in the center of a yardstick. Tie a string through the hole. Now hang the yardstick from a stand so it balances. Fill two balloons with the same amount of air. Tack a balloon to each end of the yardstick. Now prick one of the balloons. What happens?
	f2. Weigh an empty basketball on a graduated scale, in ounces. Then pump it full of air. Weigh it again. The ball with air weighs more than an empty ball.
g. Living things need air to live.	g1. See how long the children can hold their breath without having trouble.

CONCEPTS	ACTIVITIES AND RESOURCES
	g2. Observe all types of living things (plants and animals) and discuss how all of them need air to live and how they use air in their own way. g3. See filmstrip, "Air in Action, The Air."

PLANES, ROCKETS, AND SPACE TRAVEL

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. A jet engine must have air to burn its fuel.	a1. Plan a visit to the St. Paul-Minneapolis International Airport. Watch jet airplanes take off and land. Notice the exhaust. Observe. Watch the plane closely.
	a2. Show the film: "Building a Jet Plane." (11 minutes) Film Associates of California.
b. A jet engine gets oxygen from the air.	b1. Have the children report on the turbojet and how it works.
c. Kerosene is a common jet engine fuel.	c1. Have the children find out what other types of things use kerosene in order to make them work.
	c2. Report on the ramjet and how it functions.
d. Rockets and jet airplanes move forward in a reaction to escape exhaust gases.	d1. Blow air into the balloon. Close the open end of the balloon with your fingers. Hold the balloon in your hand. Remove your fingers. Do not let the balloon go. Hold it. Feel the air come out. We call this air a jet of air.
	d2. Blow air into the balloon. Close the open end of the balloon with your fingers. Place the balloon on the edge of a table. Remove your fingers. The balloon moves off the table. It moves through the air in a zigzag path.
	d3. Ask a boy to bring some roller skates to school. Have him put on the roller skates and stand before the class. Hand the pupil an inflated basketball. Tell him to toss the ball to someone straight ahead of him using the two handed push. Does the boy roll backwards on his skates? Why?
e. Rockets travel through airless space.	e1. Show a picture of an astronaut or spaceman wearing a helmet. Ask the children why a helmet is necessary. Recall the fact

CONCEPTS	ACTIVITIES AND RESOURCES
	that there is no air in outer space.
f. A rocket engine carries its own supply of oxygen.	f1. Bring in pictures of rockets and their parts. Point out the three essential parts of the rocket; the nozzle, combustion chamber, and the fuel and oxygen chamber.
g. Hot burning gases within the rocket engine will provide the push to send the rocket into space and back.	g1. Refer to Project Apollo and the live pictures taken of the takeoff, trip, landing on the moon, and return trip to the earth.
	g2. Ask the pupils to search through newspapers and magazines for pictures of spacecraft.
h. A rocket ship to the moon must be aimed ahead of the moon in its orbit because of the moon's distance from the earth and the movement of the moon.	h1. Dramatize the first lift-off to the moon, using a model rocket ship and launching pad and a ball to represent the moon. Take time to be sure the children understand that the moon travels in an orbit around the earth. Ask, "Would you aim your rocket right at the moon?"
	h2. Plan a bulletin board display of today's space attempts.
	h3. Allow the children to put together models of airplanes and rockets to learn more about the structure of these crafts.

PLANTS

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
	aa. Develop the following vocabulary: Chlorophyll, flower, fruit fungi, mold, root, spore, stem, botany, tropism, phototropism, geotropism, root hair, carbon dioxide, reproduce, asexual, bacteria, smuts.
	aa. The following filmstrips are available for use with this unit: "Structure of Plants" "Plants are Living Things" "Seeds and How They Travel" "How Plants Start Growing" "How Plants Help Us" "How Plants Live" "Parts of a Plant" "How Seeds Sprout and Grow into Plants" "Plants We Use"
	aa. The following films could be used with this unit: "Our World of Plants" "How Plants Grow" Cenco Educational Films, 1700 Irving Park Rd. Chicago, Ill. 60613 "Life on a Dead Tree" Film Associates of California, 10521 Santa Monica Blvd., Los Angeles, California 90025
a. Botany is the branch of biology concerned with plants.	a1. Bring in a botanist from the University of Minnesota to speak to the class.
b. Some plants are too small to be seen without a microscope; others are among the largest of all living things.	b1. Use a microprojector to show the children some one-celled plants such as the algae.
	b2. Show the class some pictures of the California redwoods in Prairie Creek State Park which tower over 250 feet.
	b3. Have the pupils make a list of other living things that grow very large and live long periods of time.

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CONCEPTS	ACTIVITIES AND RESOURCES
	b4. Help the class locate the largest and oldest living tree in the community. Have them measure the circumference of the candidate trees by encircling the tree with a piece of string. Measure the string.
	b5. Help the pupils learn how to identify the three most common trees in their neighborhood.
c. Plants may be classified according to green and non-green; plants with seeds and plants without seeds; or as botanists of today do, plants with tubes and plants without tubes.	c1. See if the children can find some samples of green and non-green plants. Have another group bring in some plants with seeds and some without seeds. A third group could try to bring in some plants with tubes and some plants without tubes.
d. Green plants contain chlorophyll.	d1. Obtain the water plant elodea from a store that sells aquarium supplies. Examine it under the microscope and note the green chlorophyll bodies present.
	d2. Extract chlorophyll from any green leaf by first boiling the leaf in water for several minutes to break down the plant cell walls. Prepare a double boiler with water in the bottom section and rubbing alcohol in the upper section. Place the leaf in the alcohol and heat the double boiler until the water boils, and then continue to boil for 10-15 minutes. The hot alcohol will extract the chlorophyll from the leaf and become dark green.
e. Green plants cannot survive for long without sunlight.	e1. Place two plants the same kind and size near a window. Make sure that both get plenty of sunlight. Give each of them the same amount of water each day. After a few days, carefully cover one plant with a box. The box should be large enough to cover the plant without touching any part of it. Water both plants as you did before. At the end of a week remove the box. Look at both plants. What has happened?

CONCEPTS	ACTIVITIES AND RESOURCES

CONCEPTS	ACTIVITIES AND RESOURCES

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CONCEPTS	ACTIVITIES AND RESOURCES
	e2. Note the absence or diminished plant growth in areas that do not receive much light.
f. Plants move. The general movement of plants toward or away from stimuli is known as tropism.	f1. Try watering a plant only on one side to see if the plant moves in a certain direction.
	f2. Place some heat (alcohol lamp) on one side of a plant to see if it moves toward or away from it.
g. Phototropism is the movement of plants toward light.	g1. Using a terrarium place a light source on one side of it. Notice which way the plant moves. A few days later move the light to another position. Observe the plant movement. Try placing the source of light beneath the plant.
h. All members of the highest group of green plants have roots, stems, and leaves.	h1. Have the children bring in some plants of the highest order. Allow them to find and identify the parts.
	h2. Plan a bulletin board in which the class draws pictures of the parts of plants and labels them. Put up their pictures.
i. Water enters plants through small hairs on the roots.	i1. Examine the roots of different types of plants. Using a magnifying glass find the "root hairs" which are an extension of the epidermal cells.
j. Water travels from the roots of plants through tubes in the stem up to the leaves.	j1. Obtain a fresh stalk of celery with some of the leaves still on it, and place it in a glass of water that has been colored a deep red with food coloring. With a sharp knife cut about one inch of the bottom of the stalk while the stalk is under the colored water. Allow the celery stalk to stand overnight. Note that the colored water has moved up the stalk and into the leaves. Remove tha stalk from the colored water and cut off a section of stalk from the bottom. Note the red color of the hollow tubes in the stem.
k. Roots go down into the earth. This movement of the roots is known as geotropism.	k1. Discuss the effects of gravity on plants and whether or not gravity affects the directions in which roots grow.

CONCEPTS	ACTIVITIES AND RESOURCES
	k2. Transplant some grass being careful not to bury the roots very much. Two weeks later notice if the roots moved in a downward direction.
l. Plants cannot survive for long without a water supply.	l1. Look for newspaper articles telling of sections of the country that are going through a drought. What affects does the drought have on the country and its people?
	l2. Place two like plants in seperate pots. Water both of them for a week. Stop watering one of the plants. Have the children see if they notice any differences between the two plants.
m. Most of the food manufactured by members of the highest group of green plants is made in the leaves.	m1. Have pupils bring in a white potato, a carrot, a radish, and a few leaves of lettuce. Point out that food is stored in each of these plant parts. It is possible to start several potato plants from one potato since each "eye" is a potential new plant. The radish and carrot will grow, if planted, and may bloom and produce seeds in a few weeks. It will be impossible to start new plants from the lettuce leaves. Point out that the food storage is limited in the leaf, and it will dry out or decay before a new plant could be established.
n. In order to make food, a green plant needs carbon dioxide from the air, water from the soil, and energy from the sun.	n1. Leaves need carbon dioxide for photosynthesis. Obtain a healthy geranium plant. Coat the top and bottom surfaces of one of the leaves with a thin layer of Vaseline. Keep the plant in a sunny location. In a few days the Vaseline-coated leaf will begin to turn yellow. Point out that the Vaseline prevented carbon dioxide in the air from entering the leaf's stomata and this lack of carbon dioxide stopped the process of photosynthesis in the leaf.
	n2. Leaves need sunlight for photosynthesis. Cover the leaf of a plant completely with aluminum foil. The leaf will turn yellow

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CONCEPTS	ACTIVITIES AND RESOURCES
	because the aluminum foil prevents sunlight from reaching the leaf, and this failure to receive sunlight stops the process of photosynthesis.
o. Food manufactured in the green parts of a plant is stored in many different plant parts, including the roots, stems, and leaves.	o1. Display such fleshy roots as beets, carrots, turnips, radishes, and dahlia roots.
p. Higher plants produce seeds that form in the fruit of the plant.	p1. Have the class name some plants that have seeds in the fruit part of them such as the apple, tomato, string bean, or peanut.
q. Certain groups of green plants reproduce by seeds and others by means of spores.	q1. Refer to activity p. for plants that have seeds. See if the children can name a green plant that reproduces by means of spores such as ferns.
r. The fruit of a plant forms from the flower.	r1. Show film: "Planting Our Garden" from U. of M.
s. Seeds contain stored food material. The food stored in a seed supplies the embryo plant with energy until the plant manufactures its own food.	s1. Materials: 30 bean seeds, 3 soil-filled pans. Plant the bean seeds. Plant 10 in one pan, 10 in the second pan, and 10 more in the third pan. When the seedlings begin to break through the soil, do this: In the first pan carefully dig down and break or cut off both halves of each bean seed. Do not disturb the rest of the plant. Push back the soil. In the second pan, carefully dig down and remove only one of the halves of each seed. Leave the plants in the third pan alone. Water the seedlings in all of the pans at the same time. At the end of two weeks, compare the seedlings in all three pans. How are they alike? Different?
t. The non-green plants include fungi such as bacteria, molds, yeasts, mushrooms, and smuts.	t1. Show the class some pictures of non-green plants. t2. Show film: "Fungi" - U.of M.
u. Fungi do not have roots, stems, leaves, or flowers.	u1. Bring a commercial mushroom to class for close examination. Note how it differs

CONCEPTS	ACTIVITIES AND RESOURCES
	from common green plants. The structure of the mushroom will be even more apparent if it is sliced through the center of the stem.
v. Fungi generally grow in damp regions and do not need sunlight.	vl. Materials: one slice of fresh bread, one piece of very dry toast, two jars with lids, and one open jar. Leave the bread and toast uncovered all night. In the morning, break the bread into two pieces. Put five drops of water on each piece of bread. Put no water on the toast. Put the bread into two jars. Put the lids on tightly. Put the toast into the open jar. Put one bread jar into a cupboard or another warm, dark place. Put the other bread into a refrigerator. Leave the toast jar open in the room. Observe the jars every day to see if growth is taking place.
w. Non-green plants obtain their energy from other living things or from dead or decaying matter.	wl. Plan a field trip to find and observe where these non-green plants are growing and what types of things they are growing on.
x. Most non-green plants reproduce by simple asexual means.	xl. Observe the spores that are found under a mushroom and other non-green plants. Look at them under a magnifying glass.
y. The resources of a region determine the kinds of plants that survive in the region.	yl. Outline large geographic areas in which certain major groups of plants and animals are found.
z. Trees supply many useful products.	zl. Make a list of all the things that the children can think of that are produced by trees.
aa. Most trees are grouped as either hardwoods or softwoods.	aal. Display a piece of balsam and a piece of oak. Have the children examine them and list their differences. Focus on the contrasting hardness of the oak. Display other hardwoods and softwoods. Raise the problem of how we should rank these woods from softest to hardest.

E.S.S. UNIT

ANIMALS - BRINE SHRIMP

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Brine Shrimp are small, salt-like crustaceans.	a1. Let the children figure out a way of telling how big a brine shrimp is.
	a2. To see the shrimp better put some food coloring in some yeast and then feed it to the shrimp.
b. Brine shrimp eggs are a brownish color.	b1. Give children a sheet of white paper, a magnifying glass, and sprinkle a few eggs on the paper. Let the children examine them.
	b2. Have pupils draw pictures of the shrimp.
	b3. Have children guess what they are looking at by feeling, smelling, looking, and maybe tasting.
	b4. Discuss with the class what kind of animals might come from this egg size.
c. Brine shrimp will usually hatch in salt water.	c1. Have the children make some salt water to hatch shrimp in. *See recipe suggestions on p.7.
	c2. Experiment with different concentrations of salt water.
	c3. Try hatching some shrimp.
d. Newly hatched brine shrimp will be very small and pale (white or pinkish).	d1. Use a hand lens to help see the shrimp.
e. Brine shrimp should hatch within 72 hours.	e1. Set up a bulletin board with questions the children have about brine shrimp and their answers. Also place drawings that the children have made on the bulletin board.
f. Saltwater algae and bacteria are the natural food of the brine shrimp.	

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
g. Brine shrimp will also feed on bacteria from the air, from the eggs, or bacteria from the children's fingers.	g1. Do not feed some of the shrimp any food and see if they live.
h. As brine shrimp grow they tend to have more legs.	h1. Compare the shrimp early in life and later on as they get older to notice if there is a difference in leg size.
i. Brine shrimp move differently as they get bigger.	i1. Notice the shrimp don't jerk anymore, but glide.
j. Some brine shrimp (female) have pouches filled with eggs.	j-k See if the children notice any difference between the male and female.
k. Some of the shrimp have large "arms" up by their heads. These are the males.	
l. The first eggs produced after a female matures hatch inside her body and are released as young brine shrimp.	l1. See if the children can notice a difference between a male and pregnant female brine shrimp. l2. After the young have been born see if the children can get them to "grow-up."
m. The second batch of eggs a female produces and the others after that, enter the water as eggs and have to be dried before they will hatch.	m1. Experiment by leaving some of the second batch of eggs in the water to see if they will hatch. m2. See the 16 mm. silent color film showing the life cycle of the brine shrimp.
n. Young brine shrimp when first born are attracted to light.	n1. Experiment with a light source during different stages of growth.
o. Brine shrimp shed their shells as they outgrow them.	*Follow the experiments suggested in the teacher's edition of Brine Shrimp on pp. 17-23 for further investigation. Also allow the children time to do their own experimenting. Obtain the 8 mm. film loops on "Brine Shrimp."

ANIMALS

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
	aa. Develop the following vocabulary: carnivore, herbivore, nocturnal, vertebrates, invertebrates, amphibian, reptile, mammal, community, omnivores, colony.
	aa. The following films could be used with this unit: "What's Alive" "Fish are Interesting" "Amphibians: Frogs, Toads, and Salamanders" "Reptiles are Interesting" Film Associates of California "Living Things are Everywhere" "Birds are Interesting" "Mammals are Interesting" Encyclopedia Britannica Films, Inc.
	aa. The following filmstrips could be used with this unit: "Learning About Amphibians" "Learning About Reptiles" "Learning About Birds," Encyclopedia Britannica Films, Inc. "Animals, Plants, and Their Environment" "How Animals are Grouped," McGraw-Hill Publishing Co. "Living Things," Society for Visual Education Inc.
a. Living things have life activities; they move, grow, respond, and reproduce.	a1. Have available a variety of animals in the classroom for observation.
	a2. Take a walk through an empty lot or field. Look around in your own backyard. Carry a paper bag with you. Collect small things from the top of the ground. Look for bones, feathers, leaves, seeds, and dead insects. Divide your collection into two groups, substances from living things and from non-living things.

CONCEPTS	ACTIVITIES AND RESOURCES
b. Living things are interdependent with their environment.	b1. Put two pebbles and two bean seeds into a pan of water. Put the pan on the grill and have it come to a boil. Allow it to boil for ten minutes. Let the water cool. Now look at the pebbles and the seeds. Have the pebbles changed? Have the seeds changed? Compare the boiled seeds with some that were not boiled. Do they look alike? Are they all alive? Plant them and see what happens.
	b2. Discuss how living things need a special place in which to live. A fish needs water, cows must live on land, a horned lizard on a desert, etc. See if the children can name some other examples.
c. All animals may be divided into two groups, vertebrates and invertebrates.	c1. Bring in a variety of pictures and let the children classify them according to animals with backbones and animals without backbones.
	c2. Materials: Two sheets of paper and backbones of several kinds of animals. Use some saved from chicken and fish dinners. Also you might ask a butcher for part of the backbone of a sheep or calf. Put all the bones of one fish on a sheet of paper. Put all the bones of one chicken on another sheet of paper. Then compare the bones you have with the skeletons shown in pictures. Study the backbones of the different animals. You will see that each backbone is made of many bones that fit together. Each bone looks very much like a spool.
d. Vertebrates have characteristics in common.	d1. List the five divisions of vertebrates (fishes, amphibians, reptiles, birds, and mammals). Have the children name examples of each category.
	d2. Make a scrapbook collection of the five classes of vertebrates. Collect appropriate magazines and newspapers and bring them to school. Put them on a table with scissors for free-time activity.
e. Classification of living things is based on char-	e1. Help the children in classifying their living things. Suggest that vertebrates

CONCEPTS	ACTIVITIES AND RESOURCES
acteristics held in common within the group.	and invertebrates be put into separate sections, and then that the vertebrates be further classified according to class.
f. A living thing is the product of its heredity and environment.	f1. Use 3M overhead transparency "Heredity" Printed Originals Cat. No. 4266 Prepared Color Tansparencies Cat. No. 4766
g. Animals use either plants or other animals that eat plants for the energy they need to survive.	g1. Have pupils choose one of the climatic regions of the earth. It may be a jungle, desert, ocean, or frozen wasteland. Instruct them to use an encyclopedia to find out what animals live in these regions.
h. The type and amount of food needed by an animal depends on its size and degree of activity.	h1. Use a reference book to find the weights and life span of a hippopotamus and a hummingbird. Determine approximately the lifetime energy requirements of these two animals. Discuss what would happen if one kind of animal overpopulated a region.
	h2. Several pupils in the class probably own dogs and cats. Discuss the food requirements of these animals and how these requirements are related to their activity and size.
i. Animals that feed on green plants are called herbivores.	i1. Prepare a bulletin board display. Divide the board into three groups labeled herbivores, carnivores, and omnivores. Place pictures of each type of living thing in the correct place.
	i2. Observe some herbivores animals such as cattle, sheep, and goats. See what types of plants they eat.
j. Animals that feed on other animals are called carnivores.	j1. See if the children can make their own list of animals that are carnivores. See who can make the biggest list.
k. Animals that feed on both plants and animals are called omnivores.	k1. Introduce the pupils to a third term that classifies animals according to their food intake. Examples of omnivores are man, many species of birds, bears, raccoons, and frogs.
	k2. Most children do not think of themselves as

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
b. Living things are interdependent with their environment.	b1. Put two pebbles and two bean seeds into a pan of water. Put the pan on the grill and have it come to a boil. Allow it to boil for ten minutes. Let the water cool. Now look at the pebbles and the seeds. Have the pebbles changed? Have the seeds changed? Compare the boiled seeds with some that were not boiled. Do they look alike? Are they all alive? Plant them and see what happens.
	b2. Discuss how living things need a special place in which to live. A fish needs water, cows must live on land, a horned lizard on a desert, etc. See if the children can name some other examples.
c. All animals may be divided into two groups, vertebrates and invertebrates.	c1. Bring in a variety of pictures and let the children classify them according to animals with backbones and animals without backbones.
	c2. Materials: Two sheets of paper and backbones of several kinds of animals. Use some saved from chicken and fish dinners. Also you might ask a butcher for part of the backbone of a sheep or calf. Put all the bones of one fish on a sheet of paper. Put all the bones of one chicken on another sheet of paper. Then compare the bones you have with the skeletons shown in pictures. Study the backbones of the different animals. You will see that each backbone is made of many bones that fit together. Each bone looks very much like a spool.
d. Vertebrates have characteristics in common.	d1. List the five divisions of vertebrates (fishes, amphibians, reptiles, birds, and mammals). Have the children name examples of each category.
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CONCEPTS	ACTIVITIES AND RESOURCES
acteristics held in common within the group.	and invertebrates be put into separate sections, and then that the vertebrates be further classified according to class.
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g. Animals use either plants or other animals that eat plants for the energy they need to survive.	g1. Have pupils choose one of the climatic regions of the earth. It may be a jungle, desert, ocean, or frozen wasteland. Instruct them to use an encyclopedia to find out what animals live in these regions.
h. The type and amount of food needed by an animal depends on its size and degree of activity.	h1. Use a reference book to find the weights and life span of a hippopotamus and a hummingbird. Determine approximately the lifetime energy requirements of these two animals. Discuss what would happen if one kind of animal overpopulated a region.
	h2. Several pupils in the class probably own dogs and cats. Discuss the food requirements of these animals and how these requirements are related to their activity and size.
i. Animals that feed on green plants are called herbivores.	i1. Prepare a bulletin board display. Divide the board into three groups labeled herbivores, carnivores, and omnivores. Place pictures of each type of living thing in the correct place.
	i2. Observe some herbivores animals such as cattle, sheep, and goats. See what types of plants they eat.
j. Animals that feed on other animals are called carnivores.	j1. See if the children can make their own list of animals that are carnivores. See who can make the biggest list.
k. Animals that feed on both plants and animals are called omnivores.	k1. Introduce the pupils to a third term that classifies animals according to their food intake. Examples of omnivores are man, many species of birds, bears, raccoons, and frogs.
	k2. Most children do not think of themselves as

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CONCEPTS	ACTIVITIES AND RESOURCES
	being a food supply for another animal. But there are many parasitic animals that depend upon man or other mammals as a source of nourishment. Have the pupils prepare reports on the leech, tick, mite, louse, flea, and tapeworm. Have them report to the class.
l. Some animals have protective coloration. Hence, they are not easily seen and caught by other animals.	l1. Show some pictures of animals that are hard to see because of their coloration. Let the children draw some pictures of animals and then let them try to hide the animals by using blending colors for the background.
m. Some animals search for food at night and are called nocturnal animals.	m1. Some zoos have prepared exhibits that feature nocturnal animals. It has been discovered that nocturnal animals can be induced to become active during the daytime if certain lighting conditions are set up. Plan a visit to a zoo.
n. Some animals live in organized groups or colonies.	n1. Assign small committees to prepare reports on the following colonial animals: gorillas, seals, lemmings, and prairie dogs. Have the committees report to the class.
	n2. Have the more capable students find out why beavers have become almost extinct, what steps are being taken to preserve them, and what beneficial services are rendered by beaver colonies.

CONCEPTS	ACTIVITIES AND RESOURCES

CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

MATTER - SINK OR FLOAT

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Many objects can float in water.	a-k. Develop the following vocabulary: solids, liquids, volume, bouyancy, density, and hydrometer. See Teacher's Guide, Sink or Float, McGraw-Hill Book Company, 1968.
b. Many objects sink when put in water.	
c. Many objects that sink in water can be made to float in water.	
d. Changing the shape of certain objects will determine whether they sink or float.	
e. By changing the solution of water to salt water a different effect takes place on objects and their ability to sink and float.	
f. Objects sink at a slower rate as salt is continually added.	
g. The density of the liquid is increasing with each addition of salt to water.	
h. Tap water weighs more than salt water.	
i. Different shaped objects float in different positions.	
j. Not all objects placed in a water filled tube fall at the same rate.	

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
k. Objects of the same shape and size that sink will make the water rise the same amount regardless of the material.	

ENERGY: MECHANICAL

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-k Develop the following vocabualry: machine, pulley, force, lever, resistance, fulcrum, plane, wedge, screw, axle, friction, work.
	a-k The following filmstrips could be used: "Finding Out About Simple Machines" "Machines and Tolls to Help Us Work" "Simple Machines" Society for Visual Education, Inc. "Friction at Work" "Simple Machines" McGraw-Hill Book Company
	a-k The following films could be used: "How Machines and Tools Help Us" "Simple Machines: Pulleys" Coronet Films "Machines Do Work" "Moving Things on Land" McGraw-Hill Book Company.
a. Work is done whenever a force is exerted on a body and the body is moved through a distance.	a1. Have the pupils list as many different types of work that they have done in a single day.
b. A force is a push or pull.	b1. Have each pupil make two columns on their paper titled "PUSH" and "PULL". List examples of different forces under the appropriate heading. Some examples might be: air pressure, wind, using a hammer, gravity, towing a car, or hauling.
c. Most simple machines change either force or speed.	c1. Have a large box of books in the room and have one of the smallest persons in the room try and move them. See if the class can figure out an easy way to move them.
d. Gears are used in many devices to increase speed.	d1. Obtain an egg beater. Make a mark on one of the blades of the beater. Turn the handle slowly. Count the number of turns the blade makes. How many times does the blade turn while the handle turns just once?

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
e. Machines can be used to lift, twist, pry, pound, cut, push, or pull.	e1. Let the children state some examples of machines that can lift, twist, pry, pound, cut, etc.
	e2. Have students make a list of jobs which they might do which would make use of simple machines.
f. Some machines multiply effort or force.	f1. Make a pulley. Unwind the neck of a hanger and slip a wooden spool over one end. Rewind the neck. Slip the spool to the center of the hanger. Wrap string around the wire at each side of the spool to keep it in place. Show the principle of applying force in one direction to accomplish work in the other direction.
g. There are six types of simple machines: lever, inclined plane, wedge, screw, pulley, wheel, and axle.	g1. Divide the class up into six committees. Assign each committee a simple machine to study. Have them bring in reports, pictures, and examples of their machine.
	g2. Appoint a committee to do research on the early uses of the screw, inclined plane, and wedge. Have them report to the class.
h. All machines consist of one or more simple machines.	h1. Bring in some complex machines for the class to examine. Have the pupils locate the simple machines.
	h2. Have a contest among the students. See which pupil can bring in a machine which has the most simple machines within it.
i. Machines should be used with safety precautions.	i1. Have boys write up a list of safety rules for the use of tools and machines in the home.
	i2. Have girls compile a list of safety rules to be observed while working in the kitchen.
j. Machines can do damage if they are not used properly.	j1. Relate how the correct machine should be used for the correct job. Give examples of how people sometimes use a screwdriver to do the work a wedge was made to do. Have the pupils give other examples.

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
k. Oil reduces the friction between the parts of a machine.	kl. Have the children rub their hands together. Notice the heat that is felt. Now put some water on their hands. Rub them. Notice the difference.

ENERGY: HEAT

GRADE THREE

CONCEPTS	ACTIVITIES AND RESOURCES
	aa. Develop the following vocabulary: energy, transformation, radiant energy, molecules, insulators, conductors, reflect, conduction, convection, radiation, focus.
	aa. The following films could be used with this unit: "Light and Heat" Gateway "Learning About Heat" Encyclopedia Britannica Films
a. Light energy from the sun can be changed to heat energy.	a1. Needed: a magnifying glass, a metal pan, a piece of tissue paper, and a sunny day. Place a very small piece of tissue paper in the pan. Hold the magnifying glass so that sunlight shines through the glass and onto the paper. Move the glass until you get a sharp point of light on the tissue. Moving the glass brings the sunlight to a focus. What happens?
	a2. Relate how light energy is changed to heat energy when we get sunburn or when we place a bare foot on a hot sidewalk.
b. Heat energy, a result of transformation of light energy, may be used to do work.	b1. Report on different ways to cook, cooking on a camping trip, a sun cooker used in India, and a camp stove. How are they alike?
c. Light and heat are two forms of energy.	c1. Have the children report on solar energy used in heating houses. Report to the class.
d. Heat energy is the sum of all the motions of molecules in a substance.	d1. Keep two thermometers in a shady place for a while. Read the temperature on each thermometer. When both are the same, move one thermometer to a sunny place. Wait for ten minutes. Then read the temperature on both thermometers again.
e. As the Earth revolves around the sun, the earth receives different amounts of heat.	e1. Take readings of an outdoor thermometer at different times during the day. Allow some children to take the thermometers home with

CONCEPTS	ACTIVITIES AND RESOURCES
	them and continue to take the temperature until bedtime. Report the next day. Compare with the readings of other children.
	e2. Refer to a globe of the Earth. First find the North Pole and the South Pole. Then find the line that runs around the middle of the globe. Locate our country. Compare the temperature where we live to other countries.
	e3. As a class project, compose and send a letter to your local weather bureau. Ask for information on the local temperature records: i.e., the lowest nighttime and highest daytime recordings.
f. Light energy, as it speeds up the motion of molecules of which matter is composed, is changed to heat energy.	f1. Think of a big rock on a hot summer day. Imagine sunlight shining all day on the rock. What happens to the molecules in the rock?
	f2. Have the children measure the temperature of different substances: damp sand, damp soil, warm water, ice water, and the air in different places. How are the molecules moving?
g. The sun's radiant energy can be converted into other forms of energy.	g1. Bring in a radiometer. Place it by some sunlight coming through the window. Let the children hypothesize as to what makes the radiometer turn.
h. Light from the sun can be changed to mechanical energy.	h1. Write a short story about how energy from the sun makes things move.
	h2. Extend the concept of using a radiometer to see how an enlarged one could be put to use to do some of man's work.
i. Energy from the sun can change to heat energy.	i1. Have the children explain what happens when they sit in the sun too long.
	i2. Put some water in a pan in the sunlight. After a few days notice if the water level has gone down. How has the heat of the sun affected the water?

CONCEPTS	ACTIVITIES AND RESOURCES
	i3. Observe the construction of a bridge. Explain the use of expansion joints in its construction.
j. Energy from the sun can be changed to other forms of energy, including electrical energy.	j1. Bring in a solar radio to show the class. See if someone can tell how it works. Where does it get its energy? What if the sun isn't shining?
	j2. Bring to the class a solar battery. Show its construction and how solar energy is changed into electric energy.
	j3. Have the children research and report on the telstar or Vanguard I satellite. How does it work?
k. Most clothing acts as a heat insulator.	k1. Study the types of clothing people wear in different parts of the world. Also examine the clothing worn in our state and how it changes from season to season.
	k2. Have the children report on the space suits worn by our astronauts who walked on the moon on July 20, 1969.
l. Poor conductors of heat are called insulators.	l1. Observe the building of a new house. Find the insulated material used and see where it is put.
	l2. You will need two glass jars with covers, a piece of fur or wool, hot water, and ice cubes. Fill the two jars with hot water. Wrap one in fur or wool. Let both jars stand. What do you think will happen? Why? Check your guess with a thermometer. Do you think the fur or wool put heat into the water?
	l3. Put three ice cubes and cold water in each of two jars. Wrap one in fur or wool. Put both jars in a warm place. What do you think will happen? Why?
	l4. You will need a piece of fur or wool, a pencil, and a glass of water. Put a piece of fur or wool in a glass of water. Push it down with a pencil. Look at the air bubbles.

CONCEPTS	ACTIVITIES AND RESOURCES
	15. Fill two jars with hot water. Put the cover of each jar on tightly. Next, wrap one jar loosely with paper, leaving plenty of air spaces. Wrap the other jar tightly with paper. Leave both jars for half an hour. Then remove the covers. In which jar is the water warmer?
m. Metals are good conductors of heat.	m1. You will need a pencil, a silver spoon, a stainless steel spoon, a plastic spoon, a soda straw, and a pan of hot water. One at a time, hold each of the things to be tested in a pan of hot water. Your fingers will tell which ones conduct heat quickly. Which ones do not?
n. Heat can be radiated and reflected.	n1. Discuss how a fire can warm you without touching it.
	n2. You will need a clear glass bowl and a lamp. Put the clear glass bowl around a large electric light bulb. Hold your hand near it. Turn on the light. Do you feel heat? How do you know the heat does not come from heated air?
o. Homes can be heated by conduction, convection, and radiation.	o1. Draw diagrams showing the different kinds of heating systems commonly found in the home. Point out the methods of heat travel involved in each case. Discuss the advantages and disadvantages of each system.
	o2. To show conduction; Needed: wire (9" wire from a hanger will work) wax balls, matches, candle. First melt the wax to form small wax balls. Put these balls on the wire about an inch apart. Use the candle and put the end of the wire in the flame of the fire. The heat will travel down the wire and melt the wax balls.
	o3. Fill a large beaker or Pyrex pot almost full of water. Shred a blotter with a food grater and place the fine particles in the water. Muddle the bits of blotting paper until they become thoroughly soaked and sink to the bottom of the beaker. Now place the beaker

CONCEPTS	ACTIVITIES AND RESOURCES
	on one side of a hot plate and heat the beaker. The blotting paper will indicate the path of the convection current produced in the water. The bits of blotting paper will move up the side of the beaker resting on the hot coils, and travel down on the cooler side of the beaker. o4. Heat by radiation. Turn on an electric clothes iron and place the palm of your hand a few inches below the base of the iron. The heat you feel is radiant energy that was absorbed by your hand and changed into heat.

CONCEPTS	ACTIVITIES AND RESOURCES

OUTER SPACE

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. Clusters of billions of stars are called galaxies.	a-b. Observe pictures of different galaxies. See Science in Your Life, Heath, 1968, p.288
b. Scientists believe there are billions of galaxies.	
c. A constellation is a group of stars.	c1. Study pictures of the different constellations. c2. Plan a sky watch (about 1 hour). Invite an astronomer to assist.
d. The Big Dipper is perhaps the most familiar constellation in the sky.	d-f. During the sky watch observe the Big Dipper move around Polaris (the North Star).
e. The Big Dipper seems to revolve around the North Star.	
f. The Big Dipper seems to change its position because of the earth's revolutions.	
g. The stars, like the earth, can serve as check points for measuring time.	g-h. Plot the location of stars and check their location from time to time and day to day.
h. The movements of stars denote the passing of time.	
i. A comet, like the moon, may travel in a predictable orbit. 1. Some, comets reappear. 2. Some comets do not return	i. Refer to Making a Model Concepts in Science four, Harcourt, Brace and World, 1966, p. 263. 1. Research what comets have been known to reappear. 2. Find out what comets have been seen but will not reappear.

CONCEPTS	ACTIVITIES AND RESOURCES
3. The orbit of Halley's comet is an ellipse.	3. Refer to i.
4. Meteors may be fragments of disintegrated comets.	4. Observe the sky on a clear night with no moon and away from lights. Look for comets "shooting stars" in the sky. Relate this to comets.
5. The head of a comet is a mixture of ice and rock.	5-6. Draw pictures of Halley's comet as described by scientists, stories of those who have seen one, or as books describe them.
6. The tail of a comet is a stream of very thin gases.	
7. The pull of gravity affects the orbit of comets.	7. Study the sun's gravitational pull and its effect in relation to our universe.

MOON

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. The apparent changing shape of the moon is due to its motion around the earth.	a1. Ask children to hypothesize why the moon changes shape.
	a2. Make a model of the moon's phases. Refer to Science in Your Life 4, Heath, T.E., 1968, p. 530.
b. The moon is moving in an orbit around the earth.	b. Use a planetarium to show moon's orbit.
c. The moon takes about 28 days to make one complete orbit around the earth.	c. Attach a lump of clay, or some other marker to a globe to show, approximately your locality. Set the globe in the center of a circle about 9 feet in diameter. The circle will have a circumference of approximately 28 feet. Then a one foot distance on the circumference represents the distance the moon travels in orbit during an earth day. Give the globe a complete rotation to represent a 24-hour earth day, while the child walks the circle, foot by foot. How many times will the earth rotate before the moon completes a cycle?
d. The moon reflects the light of the sun; this reflected light is called moonlight.	d. Compare the moon to a mirror. Does it have any light of its own?
e. The moon is a huge sphere containing plains, mountains, and craters.	e. Study the lunar surface through maps or actual observation.
f. The moon has no atmosphere, no bodies of water, and no living things.	
g. The side of the moon in sunlight is very hot.	g-h. Discuss the differences in temperature on earth between day and night.

CONCEPTS	ACTIVITIES AND RESOURCES
h. The side not in sunlight is bitterly cold.	
i. The gravity on the moon's surface is only one-sixth that of the earth's surface.	i. Compare the force of gravity between the moon and the earth.
j. Weak gravity may be the cause for the lack of atmosphere and the lack of water on the moon.	
k. Because of a lack of atmosphere, the shaded and sunny sides of the moon are colder and hotter than the earth.	k. Show the film, "The Moon" or "Moon-adventure in Space."
l. The mountains on the moon may be higher than those on earth because there are almost no forces of erosion on the moon.	l. Demonstrate how erosion washes away much of the earth's surface.
	Refer to Grade 3, "The Moon", for earlier concepts and activities.

THE PLANET EARTH

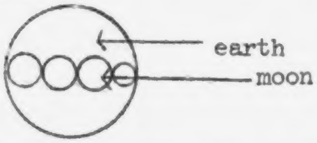
GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. Earth is about 93 million miles from the sun.	a1. Make a chalkboard diagram of the sun and the planets. Compare the size of the planets with each other and with the sun, and also show their relative distance from the sun. To get the correct relative sizes and distances, use a model of the sun that is 27" in diameter, and let 1" represent 20 million miles. On this basis show the proper size and distance for each planet.

Body	Diameter	Distance
Sun	27"	--
Mercury	1/8"	1-3/4"
Venus	1/4"	3-1/4"
Earth	1/4"	4-3/4"
Mars	1/8"	7"
Jupiter	2-3/4"	2'
Saturn	2-3/8"	3'8"
Uranus	1"	7'5"
Neptune	7/8"	11'8"
Pluto	1/8"	15'3"

Label the planets and distances.

CONCEPTS	ACTIVITIES AND RESOURCES
b. The earth is round.	b1. Show the class a globe of the earth.
	b2. Watch a boat disappear on a large lake.
	b3. During a lunar eclipse, the earth's shadow on the moon is curved.
	b4. Study photographs of the earth from jets, rockets, and satellites.
c. The earth has a circumference of about 25,000 miles.	c1. Let the children determine how far up one must go in order to see the complete curve of the earth.

CONCEPTS	ACTIVITIES AND RESOURCES
	c2. Take a piece of string and wrap it around the middle of the globe. Measure the string with a ruler. Find the "Scale of Distance" on the globe. Figure out the circumference.
d. The diameter of the earth is 7900 miles.	d1. Show the filmstrip "Our Earth."
e. The earth is about four times larger in diameter than its moon.	e. Let the children draw a circle to represent the earth. Have them place four circles stretching across the earth's equator to represent the moon. 
f. The earth revolves around the sun once every 365-1/4 days, and it rotates on its axis once every 24 hours. 1. At its equator earth rotates at a speed of about 1000 miles an hour. 2. The speed becomes smaller and smaller as we move away from the equator toward the poles.	f1. Look at classroom globe. Turn the globe through one full rotation. How long does it take? Have the earth revolve around the sun(lamp) at the same time as it rotates. How long does it take for the earth to make one complete revolution?
g. The earth rotates from west to east.	g1. Observe sunrise and sunset. Follow the path of the sun across the sky as the earth rotates. g2. Experiment: Materials: globe, lamp, plastic clay, toy soldier, east sign, west sign. Place the signs in the proper places. Have two friends hold them. Rotate the globe until the toy soldier is on the dark side of the globe. Now rotate the globe until the sun rises. Did it rise in the east or in the west?

CONCEPTS	ACTIVITIES AND RESOURCES
	Rotate the globe in the opposite direction. Where did the sun rise now? Which way must the earth rotate for the sun to set in the west?
h. One side of the earth faces the sun as it rotates; the other side is away from the sun and in the earth's shadow.	h1. Place two objects on the globe opposite to each other. Use a light source to represent the sun. The object directly in front of the sun will be at noon, and receive light. The object on the opposite side will be in darkness and the time will be midnight.
i. The rotating of the earth brings day and night. The earth has one moon.	i1. Show filmstrip, "Night and Day". See pictures of other planets and how many moons they have in comparison to the earth.
j. Earth is the only planet where the temperature of its surface is usually between the boiling and freezing points of water, so most of the water on earth is found in the liquid state.	j1. Study the distances of the other planets in comparison to the sun and determine if the other planets would be hotter or colder than the earth.
k. The earth is probably the only planet where life, as we know it, exists.	k1. Show filmstrip, "The Earth."
l. The earth's orbit around the sun is an ellipse.	l1. Place a sheet of white paper on a broad flat piece of wood. Hammer two carpet tacks or small nails, 2 inches apart, into the paper and wood. Place a loose loop as far as possible by holding a pencil point vertically against the string into the loop. Keeping the string as tight as possible and the pencil point vertical, move the pencil point all the way around the loop of string. The pencil will draw an ellipse.

CONCEPTS	ACTIVITIES AND RESOURCES
m. The earth rotates on its axis.	ml. Push a knitting needle through an orange. The knitting needle represents the axis, or imaginary line, running through the earth's north and south poles. Tilt the needle slightly and make the orange spin or rotate.
n. The earth has day and night.	nl. Get a globe of the earth that rotates, let a source of light represent the sun. Darken the room. Shine the lamp on the globe.
o. The earth's axis is tilted.	ol. Refer to activity m. First hold the needle vertically, then tilt it about 23-1/2 degrees to show how the earth rotates and revolves in this position.
p. The earth receives both direct and slanted rays from the sun.	pl. Darken the room. Shine a flashlight on the inside of the cover of a shoe box that is held vertically upright. A small intense circle of light will be produced as the rays shine directly on the cardboard. Now tilt the cardboard cover away from you at an angle of 45 degrees. The same amount of light will be spread out over a large area and will not be as bright.

GEOLOGY

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. The earth consists of three main parts: the lithosphere the hydrosphere, and the atmosphere.	a1. See filmstrip: "What is the Earth?" a2. To illustrate the parts, roll clay into a sphere. Cut out sections and paint the various layers with tempra paint.
b. The solid part of the earth is called the lithosphere. It is made up of the outer layer called the crust, the middle layer called the mantle, and the innermost region called the core.	b1. See diagram: Science Through Discovery 4, Singer Science Series, 1968 p. 72 b2. Get a styrofoam ball at least 6 inches in diameter, if not larger. By using a sharp knife, cut a good size wedge out of the ball so that the inside of the ball can be seen to the center. By using a soft pencil, draw lines on the inside of the ball to show the relative thickness of the earth's layers. Color the different thicknesses with different colored wax crayons.
c. Nonliving things of the earth are called minerals. Rock is a mixture of minerals.	c1. Play the game, "Animal, Vegetable or Mineral." Have one child name an object or substance, and have another child tell what category the object would be classified in. His choices would be either animal, vegetable, or mineral.
d. A mineral is any solid naturally occuring element or inorganic compound. Some of the properties by which different kinds of minerals are identified are hardness, chemical composition, and shape of individual crystals.	d1. Make a mineral collection in your room. Discuss in what ways the minerals are alike and how they are different.
e. Minerals take the form of crystals. A crystal is a regularly shaped solid having angles and flat surfaces.	e1. Snow is made up of ice crystals. Look at snowflakes under a hand lens. Note the shape.

CONCEPTS	ACTIVITIES AND RESOURCES
	e2. Boil a cup of water in a coffee can. Put four teaspoonfulls of rock salt into the water. Mix the salt until it dissolves. When the salt solution is cool, pour it into a jar. Hang a knotted string into the jar. Hang it from a pencil placed across the jar. Let the string stand for several weeks. Crystals of salt will grow on the string.
	e3. Repeat experiment e2, but this time boil two cups of water. Then divide the salt water. Pour one cup of salt water into one jar and the other cup into the second jar. Cool one jar of salt water slowly. Cool the other jar rapidly in the refrigerator. Let the crystals form. Compare the size. When the water cools rapidly, the salt crystals are smaller.
f. The rocks that make up the earth can be classified according to their structure and the way they are formed.	f. Examine ten different rocks. See how they are alike and how they are different from each other. When you find out their names tell how they were formed.
g. There are three kinds of rocks: igneous, which are formed deep in the earth from molten material subjected to great heat; sedimentary rocks that are formed under water and usually occur in layers; and metamorphic rocks that are formed when igneous or sedimentary rocks are changed by great heat and presure.	g. Have pieces of limestone, sandstone, shale, granite, marble, quartzite, and slate on hand. Display the rocks on a table. As pupils discuss the rocks recall that when scientists study things they find it helpful to classify them. Lead pupils to suggest ways of classifying such as color or luster.
h. The expansion and freezing of water plus the force of growing plants help break down rocks.	h1. Make a plaster of Paris, block with a crack in it. Pour in water and set the block in the freezing compartment of a refrigerator.
	h2. Bring in a rock with a crack in it. Try widening the crack by filling with water and freezing it.

CONCEPTS	ACTIVITIES AND RESOURCES
	You may need to do it many times.
	h3. Fill a bottle up to the neck with dry bean seeds. Add enough water to just cover the beans. Put a cork in. Put the bottle in a paper bag to keep the seeds dark. Seeds sprout best in the dark. In about 3 or 4 days seeds will have sprouted. What happened to the cork? Relate to the force plants have on rocks.
i. Rocks break down into soil.	i1. See filmstrips: "What is a Rock?" "Life Within the Soil."
j. Hot, molten magma collects in pools, deep within the earth. It will sometimes break through the ground forming a volcano.	j1. Make a study of famous volcanoes around the world. Find out about Anak Krakatoa, Paricutin, Mt. Pelee, Vesuvius, Cotopaki, and Surtsey in Iceland. Are all volcanoes alike?
	j2. Let the toothpaste in a tube represent magma. Squeeze the toothpaste hard and insert a pin into the metal (which represents the earth's crust.) This fault or crack in the "earth's crust" allows the "magma" which is under pressure to flow up and out.
k. An earthquake is a rolling movement of the earth's surface. Breaking or slipping of rocks beneath the earth's surface causes an earthquake.	k1. See Filmstrip: "Earthquakes and Volcanoes."
	k2. Have some capable children prepare a report on earthquakes. Include information on the seismograph.
l. Caves may be formed by the wearing away of rocks by underground streams. Deposits of limestone form stalactites and stalagmites within caves.	l1. Take a field trip to investigate the structure of caves.
	l2. Obtain some epsom salt or alum and dissolve as much of the salt as possible in each of two glasses of water resting on a piece

CONCEPTS	ACTIVITIES AND RESOURCES
	of cardboard. Place a soft, thick piece of cotton cord into and between the glasses of saturated salt solution. Tie each end of the cord around a small stone or iron washer to prevent the ends of the string from floating on top of the water. In a day or so a "stalactite" and "stalagmite" will form as the solution drops from the string evaporates, and leaves the salt behind. Real stalactites and stalagmites are formed from calcium carborate that has been dissolved in groundwater containing carbon dioxide.
m. Coal is formed from decayed plant life through a process of heat, and pressure spanning millions of years.	m1. Collect samples of coal. Break the samples apart and study them under a hand lens. Look for evidence of the ferns and plants from which the coal was formed. m2. Prepare a report on coal and coal mining. Explain how coal is mined and used. m3. Arrange a bulletin board display illustrating the theme "Uses of Coal." Post pictures showing the burning of coal in factories, homes, and electric power plants. List some products made partly from coal. Examples: perfume, nylon, aspirin, insecticides and some plastics.
n. There are two main kinds of coal: anthracite and bituminous coal.	

WATER, WEATHER AND AIR

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. Many different kinds of weather are taking place all over the world at the same time.	a. Have a variety of pictures showing an outdoor scene from different parts of the country at the same time of year. Put some temperatures on the board and allow the children to guess the temperature. Tell why you guessed the temperature you did.
b. Thermometers measure temperature marked in units, called fahrenheit degrees, or centigrade degrees.	b1. Have the children bring in some thermometers so they can learn how to read them. Call attention to the fact that each mark on the thermometer might represent either one degree or two depending upon how many marks are on it.
	b2. Obtain as many thermometers as possible so that as many children as possible will have one. Allow the children to take the temperature of a bowl of ice water from the faucet, classroom temperature, the temperature outside in the sun and in the shade, and the temperature of a beam of light from a flashlight at different distances. Keep a record of these.
c. The sun heats the land and water of the earth.	c1. Put some soil in each of two bowls. Place a thermometer in the soil in each bowl. Allow one bowl to sit in the sun, the other in the shade. Notice how the temperature will change in the bowl exposed to the sun.
	c2. Put one cup of water into each of two bowls. Make a record of the temperature of the water in each bowl. Put bowl No.1 in bright sunshine for 10 minutes. Leave bowl No.2 in the shade during this time. Now put bowl No. 2 next to bowl No.1 in the sunlight for one minute. Test the temperature of the water in each bowl with the thermometer. Keep a record.

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
d. One reason for the differences between summer and winter weather is the difference in the number of hours of sunlight.	d1. Keep a record of the time of sunrise, of sunset, and weather for a month where you live. You can get this from the newspaper, radio, or television.
	d2. Keep a record of the temperature every day for a period of time. See if there is a relationship between temperature and length of time the sun is up.
	d3. Compare the time of sunrise and sunset at different times of the year.
e. When clouds hide the sun, which is always shining, the weather becomes cooler.	e1. Fasten a sheet of tissue paper around the outside of one jar. Lay a sheet of dark paper on the inside of each jar. Lay a thermometer on each paper. Cover the tops of the jars with aluminum foil. Put both jars in bright sunlight. Record the temperature in each at the beginning of the experiment. Record the temperature every two minutes for twenty minutes. In this experiment, what is like a cloud blocking off light? (tissue paper) What is like the dark-colored earth? (dark-colored paper.) What happens to the temperature when some of the sunlight is blocked off?
f. Water does not heat up as quickly as land.	f1. Have the children recall the last time they were on the beach. Ask them if the sand felt hot and the water cool during the day.
	f2. Put 1 cup of dry soil into a bowl. Put one cup of water into the other bowl. Take the temperature near the top of the soil and the top of the water. If the water is colder than the soil, pour some out and stir in warm water until it is about the same temperature. Record the temperature. Put both bowls in a sunny place for 10 minutes. Take the temperatures again and record them. Which stays cooler in sunlight, the water or the soil?

CONCEPTS	ACTIVITIES AND RESOURCES
g. A layer of air surrounds the earth known as the atmosphere.	g. Have the children analyze the word atmosphere. Atmo comes from the Greek and means vapor. A sphere is round.
h. Air has weight and presses on the earth.	h1. Put one cup of water in a can. Place the can on a hot plate. Allow the water to boil. When steam rises from the can, put the cap in place. Remove the can from the hot plate. Rub ice cubes along the side of the can. What happens? h2. Keep an aneroid barometer in your classroom. Learn to read it. Keep a record of the air pressure in your room for two weeks. Check the reading in the morning, at noon, and in the afternoon.
i. Differences in air pressure causes the air to move.	i1. Look out of the window. Is the wind blowing now? Can you tell what direction it comes? Is it a north, south, east or west wind? i2. Make a wind vane. Use plywood to make an arrow. Mount the arrow on a stand. Let it swing on a nail driven into the stand. To mount the arrow drill a hole through it. Put a glass tube through the hole. (A medicine dropper will do, but first close one end of it by heating.) Place the tube over the nail. i3. Use an anemometer to measure the speed of the wind.
j. Air moves from a region of high pressure to a region of low pressure.	j. Study the daily weather map in the paper to observe how a high pressure area will move into a low pressure area.
k. In the sunlight, the air over water is cooler than land and at night land cools more quickly than water, as the air over the land is cooler.	k1. Refer to activity C1 k2. Put a bowl of water and a bowl of dry soil in a warm, shady place. When the soil and water are the same temperature, you are ready to start. Put both bowls in the refrigerator for 15 minutes. Take both bowls out of the refrigerator. Test the temperatures at the tops of the soil and the water with a thermometer. Which keeps

CONCEPTS	ACTIVITIES AND RESOURCES
	its heat longer, soil or water?
l. The force of the wind depends on the differences in temperature between masses of warm and cool air.	l1. Study a map showing the earth's trade winds.
	l2. In their own words have the children tell how air currents in the mountains and valleys warm and cool the land.
m. Precipitation is water that falls to the earth, in the form of rain, snow, sleet or hail.	m1. Obtain a chart of the daily precipitation as given in the newspaper or on television.
	m2. Study a precipitation map of the United States that can be obtained from the United States weather bureau.
n. Meteorologists keep accurate measurements of precipitation.	n1. Invite a meteorologist to come and talk to the class.
	n2. Plan a trip to a U.S. Weather Bureau.
	n3. Find out what type of instruments are used to measure precipitation.
o. Water is always rising into the air in the form of vapor.	o1. Place two wet spots on the chalkboard, and fan one to see that moving air evaporates water faster.
	o2. Place a shallow dish of water in the room with a sign next to it saying,"Where is the water going?"
p. Warm air holds more moisture than cold air. q. Dew is water vapor that condenses on cool objects.	p-q Add water to a shiny tin can until the can is half filled. Then add ice cubes and stir. Soon a thin film of tiny droplets of water will form on the sides of the can, as the air containing water vapor is cooled and the molecules of water vapor move more slowly and come close enough together to become water again. The thin film will gradually form large droplets. In the summer the humidity may be so high that the water vapor will condense without the ice cubes having to be added. In the winter the humidity may be so low that salt will have to be added to the cold water and ice cubes to set the water vapor to condense.

CONCEPTS	ACTIVITIES AND RESOURCES
r. Clouds are formed when water evaporates and collects in little droplets in cool air.	r-s. Fill the bottle with hot water. Pour out most of the water, leaving about an inch of it. Set the bottle in a bright light. Hold an ice cube over the opening. What will probably happen?
s. Fog is a cloud near the ground.	s1. Assign some children to write a report on how airplanes land at a fog-shrouded airport.
	s2. Using a gallon glass jug, burn a match under the open mouth to put some smoke particles in it. Then put some water in it to make the air moist. Compress the air by blowing on it; let the air expand by removing your mouth from the bottle. Do this several times. A cloud will form each time you let the air expand, and the cloud will evaporate each time you blow into the bottle.
t. As clouds cool, tiny droplets of water join to form big drops, which become heavy and fall as rain.	t1. Have the children keep a record of the kinds of clouds they see in one week's time. Tell the pupils that they should look for the following things each time they observe clouds: What was the weather when the clouds were seen? Were there quick changes in the kinds of clouds? Did the weather change too? How did the clouds move, quickly or slowly?
	t2. Boil some water in a kettle. Hold a pan of ice cubes against the cloud, cooling the water vapor molecules. They stick to the tiny drops of water. The drops get larger and fall as rain.
u. When raindrops fall through very cold air, they freeze and fall as sleet.	u1. Put into a small test tube an inch of water. Place the test tube in the center of a small tin can filled with ice chips and salt. The water in the tube will eventually freeze. The ice and salt are analogous to the very cold air that raindrops sometimes fall

CONCEPTS	ACTIVITIES AND RESOURCES
	through. The frozen water in the tube is analogous to sleet.
v. When a cloud freezes, the water vapor crystallizes and forms snowflakes instead of raindrops.	v. Open the door of your refrigerator. On the part that holds the trays of ice cubes you may see a white frost. Observe this frost with a hand lens. Do you see many little white snowflakes, one on top of the other?
w. The amount of moisture throughout the world remains the same, but is moved by the weather.	w. Have the class report on the "water cycle" explaining how it works bringing in the idea of evaporation and precipitation. Enrichment: 1. Make a collection of "weather sayings" commonly used in your community. Discuss whether the saying is based on fact or fancy. 2. Clip news stories of unusual weather conditions. Discuss the events and conditions that were observed preceding the event reported. 3. Set up a classroom weather station. Obtain a thermometer and a a barometer for your station. Use a wind vane. Make daily weather forecasts. Put out a classroom weather bulletin.

PLANES, ROCKETS AND SPACE TRAVEL

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	Develop the following vocabulary: gravity, lift, thrust, drag, ailerons, elevators, rudder, jet-propulsion, pitch, airfoil, and leading edge. The following films may be used: "Airplanes and How They Fly," McGraw-Hill Book Co; "Airplanes: How They Fly," Encyclopedia Britannica Films; "Airplanes: Principles of Flight," Coronet Films: "The Helicopter" and "Jet Propulsion,"Encyclopedia Britannica Films.
a. Flying is like swimming and walking because we move forward by pushing back against something.	a1. Stand on roller skates. Hold two large sheets of thick cardboard. Push them backward quickly. Against what are you pushing?
b. Gravity tends to pull an airplane down.	b1. Explain that gravity is a force that pulls objects toward the center of earth. Lift offsets gravity. Otherwise, an airplane could never leave the ground and remain aloft.
c. Lift causes an airplane to rise.	c1. Have each child make a paper airfoil. Give each boy and girl a piece of paper 2" by 8" for use as an airfoil. Fold the paper lengthwise, then paste or staple the edges together. Curl the paper around the pencil. Bring the curled end up to your lips. Blow across the paper. The paper rises. c2. Stick a pin through the center of a piece of a card 2" by 2". Push the pin with the card into the hole of the spool. Hold the spool with the card at the bottom. Press the card in place lightly with your fingers. Now blow through the spool from the top. Remove your fingers from the card. What happens to the card? The card does not fall.

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
d. Airplane wings are curved on top. When air strikes the front of the curve, it bounces up a little and loses some of its downward push which provides lift.	d1. Light a candle and hold it behind a card. Blow hard toward the flame from behind the card and have the children observe the movements of the flame.
	d2. Hold a magazine cover slightly open. Pull the magazine quickly through the air. What happens? When you pull the magazine forward, the cover compresses the air underneath. The compressed air pushes up.
e. Propellers driven by engines compress air and push it backward giving the thrust that pushes the airplane forward.	e1. Obtain a model airplane that has a rubber band motor. Experiment by winding the propeller half way and by holding the airplane. Let the propeller go and feel the thrust. Now wind the propeller all the way and feel the thrust.
f. Drag tends to hold an airplane back.	f1. Relate drag to friction by having the children rub their hands together and feel the heat.
	f2. Make a wind tunnel by cutting the tops and bottoms off of nine milk cartons. Stack the cartons in a honeycomb arrangement. Bind the cartons with tape. Place the cartons in front of an electric fan. Turn the fan on. You now have an airstream. Use a model airplane. Fasten ribbons to the tail and to the trailing edge of the wings. Note the way the ribbons flutter. The airstream moves over and around the streamlined plane. Now put a child's wooden block into the airstream. Fasten ribbons to the corners of the block. Observe the ribbons. The more streamline the object the less drag.
g. The forces of gravity, lift, thrust, and drag are balanced when the airplane levels off in a steady flight.	g1. Put a marble in the bottom of a glass. Hold the glass in front of you, with the open end of the glass pointed forward. Run a few steps, then stop suddenly. What happens to the marble?

CONCEPTS	ACTIVITIES AND RESOURCES
	g2. Put a file card on the edge of a table. Place a penny on top of the card. Let about half of the card extend from the edge of the table. Flick the card off the table. Use your thumb and forefinger. The card flies away, but what happens to the penny?
h. The ailerons control the banking of an airplane.	h1. Make a model airplane out of cardboard. Slit and bend the back of each wing. The slits will form the ailerons. Slide the model airplane over a wire frame. Bend one aileron up and the other aileron down. Put the model airplane in the milk-carton wind tunnel. Turn on the fan. What happens?
i. The elevators cause an airplane either to climb or to descend.	
j. The rudder causes an airplane to turn to the right or to the left.	j1. Use the model airplane again. Slit the upright tail piece to form a rudder. Bend the rudder to one side. Now place the model airplane in the wind tunnel. Turn the fan on. Which way does the airplane turn? Bend the rudder the other way. What happens?
	j2. Bring in a model boat that has a rudder. See how it works and what it does. Make the comparison between its use and that of an airplane.
k. Helicopters can fly forward, backward, sideways, straight up and down, or hover in the air.	k1. Have the children tell of their experiences with helicopters. Discuss the advantages of having one and the many places they are used.
l. The rotor of a helicopter controls its movements.	l1. Display a realistic model of a helicopter in the classroom. Demonstrate the pitch of the rotor blades.

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
m. Jet airplanes have propellers with hundreds of small blades inside the engine.	ml. Study diagrams of jet engines to get a realistic view of what makes up a jet engine.
n. Jet propulsion gives a jet airplane its thrust.	nl. Blow up a balloon. Hold the neck of the inflated balloon with the thumb and finger. Then let the balloon go. It shoots from your hands in a jet-propelled flight.
o. Escaping exhaust gases create jet propulsion.	ol. You will need an empty plastic detergent or liquid soap bottle, a cork to fit the plastic bottle, a test tube small enough to fit inside the bottle, four ounces of vinegar, baking soda and a large tub or basin. Rinse the bottle thoroughly with water. Pour four ounces of vinegar into the bottle. Loosely fill the test tube with baking soda. Carefully lower the tube into the bottle. Place the cork in the bottle. Invert the bottle and quickly place it in the middle of a tub or basin. In a matter of seconds the cork is forced out of the bottle and the boat moves forward in rapid fashion.

LIVING THINGS-PLANTS

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	a-j. Develop the following vocabulary: sequoia, bacteria, habitats, grooves, monocots, dicots, conifers, algae, fungi, mosses, ferns, spores, and migrant.
	a-j. The following films could be used in this unit: "Adaptations of Plants and Animals," "Let's watch plants grow", "Plants that Grow from Leaves, Stems, and Roots," "Seeds Grow into Plants," Coronet Instructional Films. "Learning About Leaves," "Planting Our Gardens," Encyclopedia Britannica Films.
	a-j. The following filmstrips could be used in this unit: "Flowers, Fruits and Seeds," Society of Visual Education; "How Plants Live and Grow," Young American Films; "Parts of a Flowering Plant," Curriculum Materials Corporation.
a. There are many kinds of plants and are found over all the earth.	a1. Have the pupils try to create a classification system for plants based on habitats. Discuss the difficulties involved.
	a2. Plan a bulletin board display classifying plants as very small, small, and large.
b. Scientists classify plants according to their structures and their activities.	b1. Have each pupil carefully open various seeds, for example, dried lima beans, peas, and corn, and observe them for evidence of structures that will develop as the seed germinates.
c. The way a plant reproduces is important in making a classification.	c1. Have the pupils plan a way to germinate seeds so that they can observe the structures that develop from them. Roll up blotting paper into a cylinder large enough to fill a tall glass. Insert seeds in the glass, so that they are visible to the observer. Keep the paper moist until the seeds sprout.

CONCEPTS	ACTIVITIES AND RESOURCES
d. Most kinds of plants produce seeds.	d1. Have the pupils observe seeds, such as beans, peas, corn, and seeds from cones, looking for the little scar (hilum) which indicate which it was attached to the ovary wall of its flower, and for the small hole (micropyle) used by the pollen tube.
e. Seeds produced from flowers are covered.	e1. Have the pupils prepare a display of covered seeds. Suggest that they arrange the seeds into subsets such as "food for man" and "Not food for man."
f. All flowering plants produce covered seeds.	f1. Have the pupils make collections of covered tree pods, hedge apples, acorns, as well as the typical fruits which the pupils know. Observe and compare the coverings.
g. All plants producing covered seeds have flowers.	g1. Bring in pictures of different flowers to examine and classify.
h. Exposed seeds are developed within cones.	h1. Have the pupils collect cones and needles from some of the conifers in the area. Have them identify the conifers and prepare a display comparing them.
	a-h Have each child make their own table for classifying plants.

Plant	Flower Parts		Leaf Shape		Leaf Grooves		*M	+D
	In 3's	In 4's 5's	Long, Narrow	Not Long	Full Length	Not Full Length		
Tiger Lily	✓		✓		✓		✓	

*M=monocot
+D=dicot

LIVING THINGS-PLANTS

GRADE FOUR

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Leaf Grooves		*M	+D
Full Length	Not Full Length		
✓		✓	

*M=monocot
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LIVING THINGS-PLANTS

GRADE FOUR

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GRADE FOUR

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Tiger Lily	✓		✓			✓		✓	

*M=monocot
+D=dicot

CONCEPTS	ACTIVITIES AND RESOURCES
i. Algae, fungi, mosses, and ferns are subsets of the set of plants without seeds.	i1. Have the pupils lay a mushroom crown with gills down on a piece of paper for a day. When they lift the crown, it will leave a print made up of thousands of spores.
j. Plants that do not have seeds have other means of reproducing.	j1. If possible, have the pupils secure a fern leaf and study its structures with a hand lens.

E.S.S. UNIT

ANIMALS - ANIMAL ACTIVITY

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. Gerbils are small, curious, sturdy, cheerful, friendly, industrious, but not cuddly animals.	a1. Hold a gerbil to see how they react.
b. Gerbils are desert animals and live underground.	b1. Report on animals of the Gobe Desert.
c. Classroom gerbils can adopt their living to an old bookcase, birdcage, or any other type of cage.	c1. Let the children experiment with different types of houses.
d. A gerbil will spend hours crawling in and out of cardboard or plastic tubes.	d1. Have the children bring in different types of tubes to see if the gerbils like them.
e. Gerbils gnaw for hours at plastic, cardboard, and even wire.	e1. Observe what your gerbil likes to gnaw at and what they stay away from.
f. Gerbils thrive on a regular diet of birdseed, sunflower seeds, cornflakes, and many other things.	f1. Allow the children to try a variety of food and keep a record of water they eat and how much. f2. Try a variety of the four basic food groups.
g. Most animals must have quite a lot of water, but a gerbil drinks at most only a few drops each day.	g1. See how long it takes a gerbil to consume a certain amount of water.
h. At the end of every gerbil's tail is a fine, furry lion tuft.	h1. Compare the gerbil's tail to other animals.
i. Baby gerbils are born furless, eyelids sealed shut, and are about an inch long.	i1. If babies are born, have the children keep a record of how the babies grow up and what changes take place over a two week period.

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	Enrichment Activities: 1. Read the following books while studying the gerbils: Just So Stories and The Jungle Books by Rudyard Kipling The Wind in the Willows by Kenneth Grahame The Bat Poet by Randall Jarrell

E.S.S. UNIT

ANIMALS - BONES

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. Bones differ in size, shape, function, and color.	a1. Examine some mystery bones and try to decide what type of animal it came from and the size of the animal.
b. One type of joint is the ball-and-socket.	b1. Divide up the Class Kits among the students and allow them several days to try and put the skeletons together.
	b2. Bring in a live rabbit while assembling the bones of one. Let the children feel the live rabbit's bones to help them.
c. Skulls contain an arrangement of teeth, the hinge joints of the jaw, the many holes for the nerves and blood vessels, the large eye sockets, and a brain cavity.	c1. Boil some skulls of animals, clean them, and identify them.
	c2. Study the brain capacity of the different animals.
d. Joints are required for movement.	d1. Have students write down the location of some of their own joints.
e. The backbone of a person is quite flexible.	e1. Use a gooseneck lamp to illustrate the action of the vertebral column.
f. Bones are formed by living cells,are extremley hard, and can last for thousands of years.	f1. Put a variety of bones (both real and plastic) together and let the children experiment to see which ones are real.
g. The hollow central portion of a bone is filled with soft marrow that manufactures the red blood cells.	g1. Take a hacksaw and cut through a bone to investigate its inside.
h. The soft spot on the top of a baby's head is the space between several unconnected skull bones.	h1. Examine the skull of an animal and notice the cracks between the bones.

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	*Refer to E.S.S. Unit - Bones Webster Division, McGraw-Hill Book Company, 1968.

ANIMALS

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	a-o Develop the following vocabulary: exoskeleton, head, thorax, abdomen, antennae, larva, pupa, adult, nymph, drone, pollen, reproduction.
	a-o The following films could be used with this unit: "Adaptations of Insects", Stanton Films "Ants" "Insect Zoo", Encyclopedia Britannica Films "The Butterfly", (Life cycle of an Insect) "The Honeybee", Coronet Instructional Films
	a-o The following filmstrips are available for use in the teaching of this unit: "Beetles and Their Life Cycle" "The Grasshopper" "Dragonflies and Damselflies" "Monarch Butterfly" "Honeybee and its Life Cycle" "The Housefly and its Relatiives" "The Ant" "Some Useful Insects" "Odd Insects the World Over"
a. Insects can be found almost anywhere on earth and are well adapted to where they live.	a1. Place a test tube inside a jar. Completely surround the outside of the tube with ice chips. Place an insect in the test tube. If possible use an immersion thermometer to take the temperature of the air inside the test tube. Do this several times. How does the insect react as the temperature inside the test tube becomes colder? Remove the insect. Does the insect become more active as it becomes more accustomed to the warmer temperature of the room?
	a2. Obtain a good book for insect identification.
	a3. Prepare a killing jar by using nonpoisonous material, such as ethyl acetate or alcohol, as the killing agent. Alcohol may be used for insects such as beetles, leaf hoppers,

CONCEPTS	ACTIVITIES AND RESOURCES
	ants, and true bugs. Put an inch of plaster of Paris (hardened), in the bottom of the jar. Saturate the plaster with the alcohol. Add a few layers of soft toweling or blotting paper to prevent injury to the insects. Cork the jar tightly. Have seperate bottles for bees and flies. Handle insects with forceps or tweezers.
	a4. Wood or cardboard cigar boxes are convenient for collections. Paint the inside of the box white. Corrugated paper in the bottom makes pinning easy.
b. Insects have six jointed legs and a cover called an exoskeleton. They also have three body parts called the head, thorax, and abdomen.	b1. Observe the insects the children have already collected. Find the head, thorax, and abdomen. Use a magnifying glass.
c. Some insects have a keen sense of smell.	c1. You will need two jars, aluminum foil, modeling clay, two small aluminum piepans, a piece of ripe banana, and a piece of raw beef. Wrap each jar with foil and place three marble-size lumps of clay on the lip of each jar. Put the piece of banana and the slice of beef in one jar. Leave the other jar empty. Place a pie plate upside down over the top of each jar. The lumps of clay will make a space between the jar tops and the pie plates. Place the jars outside on the windowsill. Observe these two jars. Keep a record of this experiment.
d. Insects heads have different-shaped antennae.	d1. Observe the different shaped antennae. Are they long or short, thick or thin, big or little.
e. Some insects mouths cut food; some chew or suck food.	e1. Assign reports on different insects and the way they eat.
	e2. Observe the mouths of insects under a magnifying glass. Decide how they eat.
f. Most insect eyes can see almost all the way around and up and down.	f1. Examine the eyes of a fly, moth, and other insects.with a magnifying glass and microscope. How are the eyes adapted to each

CONCEPTS	ACTIVITIES AND RESOURCES
	insect's needs?
	f2. Look at something straight in front of you. Don't move your head or your eyes. Stretch your right arm straight out in front of you. Wiggle your fingers. You can see them wiggle. Now move your arm a little to the right. Keep moving your arm to the right. Keep wiggling your fingers. When do you stop seeing your fingers? Then move your arm up. slowly, until you can't see it. Then move it down lower and lower. How far can you see up, down, and to each side?
g. Most insects have four life stages: egg, larva, pupa, and adult.	g1. Trace the life cycle of some insects, using appropriate pictures or drawings. Note the changes.
	g2. Prepare a large chart of the growth of insects. Label the chart according to each stage of growth. Put up pictures of each stage.
h. Some insects have three life stages: egg, nymph, and adult, such as the grasshopper.	h1. Find out what other type of insects go through a three cycle stage of growth.
i. Insects survive in great numbers because each kind lays many eggs in different places and they have special types of movement.	i1. List the many places that insects lay their eggs.
	i2. Dragonfly numphs propel themselves through the water much like small jets. You can simulate this movement by filling a small round balloon with water and placing the balloon in a large container of water. Note how the balloon moves as water is forced out of it.
	i3. Obtain a large, live grasshopper. Measure the distance the grasshopper jumps. Measure the length of the insects body and determine how many times its own length the grasshopper is able to jump. Point out the beneficial aspects of this trait to the grasshopper including his many enemies.

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	i4. If possible, obtain a water strider. Place it in a large container of water. Notice how they are able to walk on top of the water, supported by the surface tension of the water.
j. Color and shape protect many insects.	j1. Refer to the Weekly Reader - World of Insects pictures. Show these pictures by displaying them on a bulletin board. Have the pupils tell which insects might be protected by their color and shape.
k. Insects that live and share the work (ants, bees, hornets, etc.) are called social insects.	k-1 A beehive may be purchased for a school. This would allow firsthand observations of the bee community.
l. The food of honeybees is stored in cells in the hive and is used all year.	
m. Ants live in colonies. n. The queen lays the eggs.	m-n Obtain an ant farm so that the children can raise, feed, and observe the life of an ant.
	m-n Look for ants in the school yard or at home. Examine them closely. Note how the ant is always cleaning its antennae. Follow the ants to their nest. Try to find the queen ant. Observe the behavior of the ants.
	m-n Have the class make a clay model of an ant colony.
	m-n Have the children locate information about the types of ants in a colony and the function of each type.
o. Insect pests may spoil crops, carry disease, or spoil stored food.	o1. Have the class report on destructive insects and their control, assigning specific insects (termites, gypse moths, tobacco worms, etc.).
	o2. Report on the causes of malaria and yellow fever.

CONCEPTS	ACTIVITIES AND RESOURCES
	Enrichment activities: 1. Put a light outside during the evening. Observe the insects that gather. Try to collect some. 2. Invite a biology teacher to come and speak to the children.

E.S.S. UNIT

MATTER - MYSTERY POWDERS

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. The activities in Mystery Powders deal with the properties of ordinary white powders (starch, baking soda, plaster of Paris, granulated sugar, and salt) and the use of indicators in identifying them and detecting their presence in mixtures. The powders are safe for children to handle and taste and are inexpensively obtained from drug, grocery, and hardware stores. In learning to identify the powders and devising ways of distinguishing them from one another, students obtain answers to their questions directly. This experience provides an introduction to some methods of investigatory science. In the course of their experiments with the powders, students become aware of many physical and chemical properties of common substances. From beginning activities in which they use their senses to become familiar with the powders, students progress to more sophisticated analysis, utilizing indicators and	a1. See Teacher's Guide, Mystery Powders, McGraw-Hill Book Company, 1967.

CONCEPTS	ACTIVITIES AND RESOURCES
other laboratory techniques. This unit has been taught primarily in the third and fourth grades. However, some teachers in higher grades have used Mystery Powders as an opener to a year's study in science. The activities can be completed within ten lessons of about 45 minutes each.	

MATTER

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	a-n Develop the following vocabulary: molecule, atom, solid, liquid, gas, theory, vibrate, evaporate, oxygen, air pressure, compressed air.
	a-n The following filmstrips could be used in teaching this unit: "Atoms and Molecules" "Molecules and You" McGraw-Hill Book Company "What is an Atom?" "What is Matter" Benefice
a. A molecule is the smallest single particle of a substance and molecules are made of still smaller particles called atoms.	a1. Have children read the paperback book called Atoms put out by Arrow Book Company, Scholastic Book Service. Report to the class on the book.
b. Molecules move rapidly all the time yet this cannot be seen.	b1. You will need a shoe box, a large onion, and a knife. Close the doors and windows. Cut the onion in half. Put one piece in a covered shoe box and the other on the table in front of the room. Now have the class sit back and wait. Can you explain how the onion odor reached your nose? Open the shoe box and sniff. What a strong odor--much stronger than the onion smell in the room. Can you explain the stronger odor in the closed box, using the idea of molecules?
	b2. Procure ten or a dozen small jars with tight covers. Number the jars. Have small wads of absorbent cotton so liquids will not spill. Saturate the cotton with as many harmless substances as can be thought of, such as: vinegar, perfume, vanilla, oil of peppermint, alcohol, turpentine, and so on. Put one substance in each bottle (keep a secret "key"). Have the children try and guess what is in each jar.

CONCEPTS	ACTIVITIES AND RESOURCES
	b3. There are many air purifiers on the market that make use of this fact of moving molecules. Perhaps there would be some children who would like to find out more about these commercial ones. How effective are the air purifiers? How many are sold? Are they used in homes or public buildings?
c. The three states of matter are solid, liquid, and gas.	c1. Get two or three of the following items: several stones of different size and shape, muddy water, a partly filled balloon, some paste, a rubber sponge, a bottle of pop, and some salt. Also encourage the children to bring in other items. In a notebook make three columns. Label them solid, liquid, gas. Write the name of one of the items you have chosen in the column that you think is correct.
	c2. Show that solids, liquids, and gases are forms of matter because they occupy space and have weight. A book or a uniform block of wood are solids that can be measured and weighed easily. Pouring water into a glass jar will show that a liquid occupies space, and weighing the jar before and after pouring will show the liquid has weight.
d. The molecules of a solid hold their place. Even though the molecules vibrate rapidly, there is strong attraction that keeps the molecules together.	d1. Refer to activity c2.
	d2. Get some ice cubes. Put them in two bowls. Put one bowl in a shady part of the room and one bowl in a warm or sunny place. Place a thermometer in each bowl. Look at the thermometer every five minutes. Record the temperature. Describe any changes in the appearance of the ice cubes.
e. The molecules vibrate more rapidly and are no longer firmly attracted in its liquid state.	e1. Have the children try and explain the difference between molecules in a solid state and in a liquid state.
	e2. Discuss what happens when someone dives into water. Do the molecules of water let you go through?

CONCEPTS	ACTIVITIES AND RESOURCES
	e3. You will need a glass of water and a tablet of vegetable dye (like the dye used for coloring Easter Eggs). You will also need a watch or a clock, crayons, and some paper. Drop the dye tablet into the water. Don't touch or shake anything. Just let the glass stand and see what happens. Give plenty of time. Every three minutes make a colored sketch of what you see.
f. Dissolving occures when molecules of a liquid bump against molecules of a solid and push them away from the solid.	f1. Obtain some lumps of sugar, water, a clock, a spoon, and two pans. Try and find the answers to the following questions: Will a lump of sugar dissolve faster if it is stirred? It it is crushed? Does sugar dissolve faster in warm than cold water? Is there a limit to how much sugar will dissolve in a cupful of cold water? If so how much?
g. Gas molecules move most rapidly and their molecules are farther apart than in a liquid or a solid.	g1. Observe some boiling water. Explain what is happening. g2. Put the same amount of water in three containers such as a pan, cup, and pop bottle. Let them stand and observe them every day. From which container will the water evaporate soonest?
h. Most gases are invisible because their molecules are far apart.	h1. See if the children can name some gases that they know of that can't be seen. How do they know they are there?
i. When a gas is cooled, the molecules are slowed down.	i1. Fill a tin can with ice cubes and cover it. Wipe the outside of the can completely dry. Do you see little drops begin to form? Wipe the can and repeat the experiment. This time use a watch and keep a record of the time it takes until the first drop of water rolls down.
j. Air is the most useful gas in the world. About one-fifth of air is oxygen.	j1. To show that air is useful tell the class to see how long they can hold their breath. j2. Float a cork in a large glass jar or aquarium half full of water. Ask if anyone can make the cork go to the bottom of the water

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	without touching it. If no suggestions come from the pupils, hold up a drinking glass upside down over the cork and gently push it down to the bottom of the glass jar.
k. Air moleucles move rapidly in all directions.	k1. Try to bounce an empty balloon. Does it bounce? Now blow the balloon full of air, tie it, and try again. Now does it bounce?
	k2. Squeeze the balloon in one place. Feel the balloon push back in that place. Push the balloon down against the table. Feel the balloon push up. Wherever you push, there is a push right back from the moving molecules of air inside.
l. The push of air molecules in all directions is called air pressure.	l1. Have someone bring in a tire and a pressure guage. See how much pressure is in the tire.
	l2. Press a piece of cardboard over a glass full of water. Hold the card and turn the glass over. Take your hand away from the card. Does the card fall off and the water pour out?
	l3. Explain the workings of a vacuum cleaner and an electric fan.
m. Molecules are everywhere and everything is made of molecules.	m1. Look around you and think of molecules. Have the children try to summarize what they have learned.
n. The molecules in an element are alike; the molecules in a compound are different.	n1. See how many elements and compounds you can find in your home. Make a list of them and bring them to class.

E.S.S. UNIT

ENERGY - PENDULUMS

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. Pendulums gives children a chance to observe, investigate, and reflect upon the many physical phenomena associated with swinging objects. A variety of bobs, differing in weight, size, and shape, lead the children to ask questions about a pendulum's behavior and to find their answers from the pendulum itself. Here is an opportunity for the students to make and test our predictions in a readily controllable situation. The Teacher's Guide suggests initial investigations of swinging things. Can you get two bobs of equal weight to swing together? Can you make the bob go in a circle? The children can race pendulums and time how long various "round trips" take to complete. Linking a pair of pendulums with a dowel opens a door to the unexpected . . . how to account for the behavior of coupled pendulums. Attaching a leaking cup of salt to a pendulum allows children to trace the pattern of a swing and make symmetrical designs. Finally, children can sharpen their	a1. See Teacher's Guide, Pendulums, McGraw--Hill Book Company, 1966.

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
ability to predict what a pendulum will do by playing a variety of engrossing games that depend on an intuitive grasp of the complex motions of a swinging bob. Work with the pendulums can go on at any grade level, but the unit itself has been used most successfully in Grades 4 through 6. It should take four to six weeks to complete. If materials are left at the side of the classroom, the children can use them indepently.	

E.S.S. UNIT

ENERGY - BATTERIES AND BULBS

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
a. Batteries and Bulbs is an introduction to the study of electricity and magnetism. In the course of this study, each child carries out experiments with simple and safe equipment---flashlight batteries, small bulbs, various kinds of wire, magnets, and compass---and draws conclusions based on his observations. At first, each child is given a battery, a bulb, and a piece of wire and asked if he can light the bulb. When he has explored the possiblbities of these materials to his satisfaction, he goes on to investigate such questions as: Can you light several bulbs with one battery? What happens if more than one battery is used in a circuit? Do varying lengths and types of wire influence the brightness of bulbs? Students predict, compare, and discuss results. They attempt explanations and simple rules that will account for the behavior they observe. The conclusions and predictions that a child makes can be tested by himself or by other children.	a1. See Teacher's Guide, Batteries and Bulbs McGraw-Hill Book Company, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES
The unit is designed primarily for use with Grades 4-6. The first four sections lend themselves nicely to simple explorations in Grades 2-3. The unit can take anywhere from seven to 12 weeks. In Grades 3-6, about 45 minutes should be allowed two or three times each week.	

LIGHT

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	a-m Develop the following vocabulary: reflected, absorbed, energy, convex, diffuse, polarize, spectrum.
	a-m The following films could be used: "How to Bend Light" "Light and What It Does" Encyclopedia Britannica Films, Inc. "All About Light" Cenco Educational Films
	a-m The following filmstrips could be used: "Light" Encyclopedia Britannica Films "Light" "Light and Color" McGraw-Hill Publishing Co. "Light and How It Travels" "Light and Color" Jam Handy Organization.
a. Objects become visible as light is reflected from them to the eye.	a1. Invite a volunteer to look through a peephole punched in a shoebox that contains some familiar objects. The box is made as light-tight as possible by sealing it with tape. In the top of the box, opposite the peephole, is a large opening to let in light, covered with a card hinged with tape to the box top. Open and close the light opening quickly, so that a brief glimpse is possible. Another volunteer may see a different object, in his turn.
b. Light can be reflected and absorbed.	b1. Open to a clean white page inside the front or back cover of a book. Prop the book against the light so that the open page is in a shadow. The darker the shadow, the better. Hold a mirror in front of the book, in the light. What happens to the dark page? Hold a piece of white paper in front of the book. What happens to the dark page? Now hold a piece of black paper in the light in front of the book. What happens to the dark page now?

CONCEPTS	ACTIVITIES AND RESQURCES
	e2. Needed: A magnifying glass (convex lens), a pie tin or metal plate, a piece of paper, a piece of cardboard, sunlight. Hold the convex lens between the paper and the sun, and facing the sun. Move the lens back and forth between the sun and the paper until a small and bright spot of light rests on the paper. Hold the lens in that position. What happens to the paper? What does this show about the spot of light? Keep the lens in the same position. Hold the piece of cardboard near the lens and then move it away from the lens toward the spot of light. What is the shape of the light coming through the lens?
	e3. Fill an aquarium with some water. Add a few drops of milk to make the water cloudy so that light passing through the water can be seen. Aim a beam of light at the water. What happens to the beam of light as it enters the water? Now place a mirror at the bottom of the tank under the water. What happens to the light when it strikes the mirror?
	e4. Put a coin in an empty saucer. Then get down so that the edge of the saucer just hides the coin from your eyes. Pour in water, slowly and carefully. The coin will slowly appear above the rim of the saucer.
f. Light energy may be released by a chemical change. The light energy of a candle comes from paraffin.	f1. Needed: A candle, a ruler, a pencil, a candle holder, a clock or watch. Mark inches and half-inches on the candle with the pencil and ruler. Put the candle in the holder. Light the candle and write down the time. Let the candle burn in a place where there are no drafts, so that the flame burns steadily. Be sure it is a safe place. How long does it take for half an inch of the paraffin to disappear? How long does the next half-inch take to disappear? What appears as the paraffin disappears? What do you think happens to the paraffin?

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	f2. Have the children read about and report on such sources of light as the sun, torch, kerosene lamp, gas lamp, gasoline lamp, electric light, fluorescent light, and neon light. Let them describe how each source is produced. Make a display or exhibit of as many of these sources as are available.
g. Carbon dioxide and water are products of burning.	g1. Needed: two jars, a short candle, a piece of tape, limewater. Stick the short candle in one jar with melted wax. Blow out the flame and pour about an inch of clear limewater into the jar. Be sure the second jar is dry. Light the candle. Carefully lower the mouth of the second jar on to the mouth of the first jar. Let it rest there. The candle will burn for a few moments in the jar. What happens in the jar above the flame? After the candle has gone out, use the tape to join the jars together without letting air in. Then shake gently so that the limewater and the air in the jars are mixed. What happens to the limewater?
h. Light travels at 186,000 miles per second.	h1. Have the children read about and report on how the speed of light was determined. Let them calculate the time it takes for the sun's rays to reach the earth 93 million miles away. Some children may be interested in calculating the distance traveled in one light-year. This distance can be found by multiplying 186,000 by 60 seconds, then by 60 minutes, then by 24 hours, and then by 365¼ days. Miltiplying this answer by 3 1/3 will give the distance traveled in a parsec.
i. Light can be polarized by certain materials.	i1. Needed: Two pieces of polarized plastic or glass. Look through one piece of polarized plastic. Does light pass through it? Turn the piece clockwise. Does light still pass through? No matter how it is turned, light passes through it. Do the same with the other piece of polarized plastic. The results are the same. Now place one piece on the other, and look through both. Turn one of the pieces,

CONCEPTS	ACTIVITIES AND RESOURCES
	holding the other piece still. What happens as one of the pieces is turned?
j. White light is a mixture of all frequencies in the visible spectrum.	j1. On a sunny day, when the sun's rays are coming through the window into the classroom, hold a prism in the path of the sunlight. Roll the prism around until you are able to throw a rainbow on the wall. Have a child tape a white cardboard to the wall so that the spectrum will show up more clearly. Ask the children to locate and identify the different colors of the spectrum.
k. The colored lights of a spectrum can be recombined.	k1. Repeat activity j1., but now place a magnifying glass (convex lens) between the prism and the cardboard. Move the magnifying glass back and forth until you make the spectrum disappear and there is only a spot of white light on the cardboard. Point out that the convex lens of the magnifying glass caused the colored lights of the spectrum to converge and combine, forming white light again.
l. A rainbow is a spectrum that is produced when the sun shines during or immediately after a rain shower.	l1. Take the children outside on the school lawn in the early morning or late afternoon. Stand with your back to the sun, facing a dark background if possible. Adjust the water from a garden hose so that a fine spray is produced. Now spray the water upward. A rainbow is produced as the water droplets, acting like tiny prisms, break up the sun's rays to form a spectrum.
	l2. Make and trap a rainbow by allowing one drop of Duco cement to fall into a clean glass pie plate full of water. The cement will spread out on top of the water to form a thin film with rainbow colors in it. Slide a piece of black construction paper under the film and carefully lift it out of the water. You will have trapped a rainbow permanently.

CONCEPTS	ACTIVITIES AND RESOURCES
m. A material is colored because, when white light strikes the material, all the colored lights have been absorbed except one, which is reflected to the eye.	m1. Call the children's attention to the color of their clothes and of other objects such as pens, pencils, chalk, crayon, and book covers. Point out that each material has a certain color because, when white light strikes the material, all the colored lights have been absorbed except one, which is reflected to the eye.

SOUND

GRADE FOUR

CONCEPTS	ACTIVITIES AND RESOURCES
	a-j. Develop the following vocabulary: vibration, pitch, molecular motion, echo, waves.
	a-j. The following films could be used: "Sound and How It Travels" "Vibrations" Encyclopedia Britannica Films "Sounds Around Us" Cenco Educational Films.
	a-j. The follwing filmstrips could be used: "Sound" Encyclopedia Britannica Films. "Exploring Sound" McGraw-Hill Publishing Co. "Finding Out About Sound" Society for Visual Education, Inc. "The Nature of Sound" "How Sound Travels" Jam Handy Organization.
a. All sound is caused by vibrations.	a1. Stretch a rubber band across the top of a cigar box. Pluck it and listen. Use different size rubber bands and stretch them to various degrees of tightness.
	a2. Set a tuning fork vibrating by striking one prong sharply against your kneecap or the rubber heel of your shoe. To show that the tuning fork is vibrating, hold one end of a sheet of paper and touch one prong lightly to the other end of the paper. The vibrating prong will make the paper rattle.
b. Vibrations set up sound waves that travel in all direction.	b1. Place children in four corners of the room, facing the wall. Then have one child stand in the middle of the room and produce a sound. Let the children raise their hands as soon as they hear the sound. Now place one child at the top of the stairs, a second child half-way down, and a third child at the foot of the stairs. Have the child half-way down the stairs make a sound. The sound will travel up and down, as well as in all horizontal directions.

CONCEPTS	ACTIVITIES AND RESOURCES
	b2. Fill a large beaker or tumbler full of water. Strike the prongs of a tuning fork very sharply against your kneecap or the rubber heel of your shoe, and then quickly place the ends of the prongs in the center of the water. The vibrating prongs will make the water splash out of the beaker in all directions.
c. Sound travels through all three forms of matter.	c1. Solids - Stand at one end of a table and have a child stand at the other end. Scratch the table top so lightly with your fingernail that the child cannot hear the sound. Now have the child place one ear against the end of the table, and then scratch the table top again. The child will hear the scratching sound very clearly.
	c2. Liquids - Fill a large aquarium almost full of water. Pound two rocks together about six to eight inches from a child's ear. Now have the child place his ear against one end of the aquarium. Pound the rocks together again, this time under the water in the aquarium. The child will hear the sound, but it will be much louder.
	c3. Gases - Obtain a garden hose that is fifty feet long. Send one child out of the room with one end of the garden hose, and have another child speak very softly into the other end of the hose. The child outside the room will be able to hear the words very clearly.
d. Sound does not travel through a vacuum.	d1. Obtain a large Pyrex flask and a solid rubber stopper that fits the mouth of the flask. Push a small hook into the underside of the stopper. From the hook suspend a string that is attached to a small jingle bell so that the bell will hang freely inside the flask when the stopper is inserted. Place a small amount of water in the flask, set the flask on a hot plate, and boil the water until almost all the air inside the flask has been driven off and there is

CONCEPTS	ACTIVITIES AND RESOURCES
	mostly steam inside the flask. Remove the flask, insert the stopper, and allow the flask to cool. The steam will condense, leaving a partial vacuum in the flask. Set up a second flask exactly like the first, but do not boil the water so that this second flask is full of air. Now shake both flasks gently. Compare the loudness of the bell in the partial vaccuum with that of the bell in air.
e. The pitch of sound depends on the length and thickness of the vibrating objects.	e1. Needed: a comb, a piece of thin, stiff cardboard. Hold the comb in one hand and the cardboard in the other. Hold the cardboard lightly but firmly. Pull the cardboard slowly and steadily along the teeth of the comb. Listen to the pitch of the sound that is made. Now pull the cardboard faster along the teeth. What happens to the pitch of the sound? Does the pitch change? Does it get higher or lower? Move the cardboard along the teeth of the comb at different speeds until you are sure what happens to the pitch. Now draw the cardboard along the teeth very slowly. Observe what happens to the cardboard.
f. Sound waves may echo when they are reflected from solid objects.	f1. Bring the children to the school auditorium or gymnasium when it is empty. Stand at one end of the auditorium and produce echoes. Have the children recall that these echoes are not heard when the auditorium is filled. The sounds are absorbed by the persons in the auditorium.
	f2. Have a child bring in a Slinky. Pinch a few of the coils together and let them go, quickly. The wave that travels the length of the extended Slinky will bounce back from the end of the coil.
g. The human voice is produced when air is forced through the vocal cords thus causing them to vibrate.	g1. Have the children put their fingers on their throat and feel the vibrations as they speak.

CONCEPTS	ACTIVITIES AND RESOURCES
h. When the sound waves reach our ears they cause the ear drum to vibrate.	h1. Examine and discuss a model of an ear and hearing aid.
i. Sound travels approximately 1,100 feet per second in air.	i1. Find two flat pieces of wood that make a sharp crack when slapped together. Ask a child to carry them to a far corner of the playground. As he makes a sound with them, do you see the wood come together before you hear the sound?
	i2. Have the children read about and report on the speed of sound in air, water, and solids. Discuss the effect of temperature on the speed of sound, pointing out that heat produces an increase in molecular motion.
j. Humans can hear sound waves ranging in frequency between 20 and 20,000 vibrations per second.	j1. Blow a dog whistle. Point out that our ears can only hear sounds within a definite frequency range. Have the children read about and report on the uses of ultrasonic sound waves.
	Enrichment Activities: 1. Pop Bottle band - - - Fill different glasses or bottles with various amounts of water. Use eight glasses and produce the notes of the scale. 2. Have the class bring any object from home which will make a sound. Have them demonstrate these and then discuss what made the sound. 3. Have the class sit still for five minutes and listen to the sounds around them. Make a list of all the things that they heard. 4. String Telephone - Needed: About 10 feet of string, two paper cups, a wall, a pencil. Make a small hole in the bottom of each cup with the pencil point. Put one end of the string through the hole and knot the string

CONCEPTS	ACTIVITIES AND RESOURCES
	so that it cannot come out. Have a classmate hold one cup to his ear. Stretch the string tight, and whisper some numbers into the string telephone. Your classmate should repeat them aloud, to show that he has heard them.

CONCEPTS	ACTIVITIES AND RESOURCES

OUTER SPACE

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-1 See T.E. Today's Basic Science 5, Harper and Row, 1967, pp. 62-84.
	a-1 See T.E. Concepts in Science 5, Harcourt, Brace, and World, 1966 pp. 134-151.
	a-1 See T.E. Science in Our World 5, D.C. Heath, 1968, pp. 412-427
	a-e Show filmstrip, "What is a Star?"
	a-e Show filmstrip, "The Sun."
	a-e Show filmstrip, "The Stars."
	a-1 Develop vocabulary terms: asteroid, comet, concave, converge, convex, diverge, galaxy, magnitude, meteor, meteorite, reflect, refract, spectroscope, prism, and light-year.
a. Stars are suns; our sun is a star.	al. Use a prism to show different colors in light. Have children make their own prisms using various materials.
b. Stars are made up of hot gases that give off heat and light.	bl. Use an alcohol lamp to determine temperature and color of flame relationship.
c. Stars differ in color, temperature, magnitude, size, and distance from the earth.	cl. Collect spectrum data and make a chart showing composition, temperature, and color.
d. Bodies in space, as well as their matter and energy, are in constant change.	dl. Discuss and describe nuclear reaction that is continually taking place inside the sun. Compare this reaction with that of a hydrogen bomb.
e. The light from stars enables us to determine their composition and temperature.	el. Heat a piece of wire until it glows. Observe the color changes and compare these to star colors.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
f. Distances in space can be measured accurately by using the speed of light as a yard stick.	f1. Bounce a ball off walls of different distances to show that time of return can be used to measure distances.
g. The Milky Way is a galaxy or system of stars.	g1. Look for and collect pictures of stars, double stars, different varieties of star clusters, nebulae, and galaxies.
h. Meteors are masses of stone and metal from outer space.	h1. Look for "shooting stars." These meteors are very easily seen. Meteor showers are named after the constellations from whose direction the meteors seem to come. Look for the Perseid shower about August 10-14, the Orionid shower about October 20-24, the Geminid shower about December 10-14, and the Leonid shower about November 15-19. Also see The World Almanac.
i. Stars are studied with the aid of telescopes and radio telescopes.	i1. Make a constellation box, using a shoe box, flashlight and pin. Show in darkened room.
	i2. Show filmstrip, "Astronamy Through the Ages."
	i3. Develop special reports on famous observatories.
	i4. Show filmstrip, "Man Becomes An Astronomer."
j. A convex lens causes light rays to converge; it magnifies an image.	j-k Allow children to experiment with concave and convex lens.
k. A concave lens causes light rays to diverge; it makes an object look small.	
l. A refracting telescope contains an objective lens and an eyepiece lens.	l1. Have children bring in a telescope from home to demonstrate and show the parts of it.
	a-1 Culminating activity. Take a field trip to the Minneapolis Library Planetarium.
	a-1 Use E.I.S. unit, The Universe.

SOLAR SYSTEM

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-n See T.E., Today's Basic Science 5, Harper and Row, 1967, pp. 62-84.
	a-n See T.E., Concepts in Science 5, Harcourt, Brace, and World, 1966, pp. 90-143.
	a-n Show filmstrips; "Life on Other Planets" "Laws of the Sky" "The Earth in Space" "Time, Space, and Energy" "What is a Solar System?" "What is Gravity?"
	a-n Develop vocabulary terms; asteroid, comet, galaxy, meteor, meteorite, planet, reflect, orbit, luminous, and non-luminous.
a. Our solar system is a part of the Milky Way galaxy.	al. Simulate twinkling of stars. Focus light source on a screen. Place source of heat near lens so that rising heat waves will cause light to flicker.
b. Several theories have been proposed to explain how the solar system was formed.	bl. Prepare reports on the "Planetismal Theory," "Dust Cloud Theory," and "The Nebular Theory."
c. The solar system consists of the sun, planets, moons, asteroids, and comets.	cl. Demonstrate use of parallax to determine the distance of the planets from the sun. Hold a finger about six inches in front of the face. Look at finger first with one eye, then with the other.
d. In order of distance from the sun the planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.	dl. Make a diorama of the solar system. Suspend balls of paper machè in a large cardboard box. Use the following astronomical symbols for the planets. They are illustrated on the next page. Also see p. 304 of the student book grade 5 of D.C. Heath.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	Mercury ☿ Venus ♀ Earth ⊕ Mars ♂ Jupiter ♃ Saturn ♄ Uranus ⛢ Neptune ♆ Pluto ♇
e. Our sun is a star.	e1. Show photographs of a solar eclipse as well as sunspcts and solar prominences.
f. All planets revolve around the sun.	f1. Encourage students to locate planets in the sky. Local newspapers and astronomy magazines list when and where in the sky certain planets may be seen.
g. The planets are held in their orbits by gravitational attraction between them and the sun.	g1. To discover which planet orbits the sun in the shorter time and which planet takes the most time to complete one orbit try this: 8 feet of strong string small rubber ball Attach the string to the ball. Grasp the string three feet from the ball. Now whirl the ball just fast enough to keep it circling at one level. How many times does it circle your head in one minute? Have someone count for you. Now whirl the ball with 4 feet of string, then do it with 5, 6, and 7 feet of string.
h. To alter the path of a body in space, energy must be applied to affect the relationship between gravitational pull and inertial motion.	h1. Place a penny on a card over a glass. Show that energy applied to the card (flick with finger) will result in a change of position while the penny will fall into the glass as as result of not having the same energy applied to it.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
i. Planets, moon, and asteroids are non-luminous bodies in the solar system. They are visible because they reflect sunlight, or shadow other bright bodies.	i1. Darken the room. Let a rubber ball represent a planet. The "planet" can barely be seen. Let a flashlight represent the sun. Shine the flashlight on the ball and observe it can now be seen by means of reflected light.
j. Five planets can be observed with the unaided eye from earth. These are Mercury, Venus, Mars, Jupiter, and Saturn.	j1. Encourage a student to build his own telescope. Report on progress.
k. Comets are luminous bodies.	k1. Discuss Halley's comet. Write reports on its expected return in 1986.
l. Asteroids are planet-like objects which revolve around the sun in fixed orbits.	l1. Use diagram in student text, Today's Basic Science, Harper and Row, 1967, p. 117.
m. Meteors are bodies of matter that are made luminous by friction as they move through the atmosphere.	m1. Look for "shooting stars." Meteors are easily seen especially in the summer.
n. In order to support life as we know it, planets must have certain environmental conditions. These are an atmosphere in which there is oxygen, food supply, shelter and temperature.	n1. Have the children read about conditions such as temperature, atmosphere, and water on other planets and discuss the possibility of life as it exists on earth, on these planets.

THE MOON

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-j See T.E., Today's Basic Science 5, Harper and Row, 1967, pp. 62-84.
	a-j See T.E., Concepts in Science 5, Harcourt, Brace, and World, 1966, pp. 48-79.
	a-j See T.E., Science in Our World 5, D.C. Heath, 1968 pp. 412-427.
	a-j Use the following filmstrips: "The Moon, Our Silvery Moon" "Man and the Moon" "Flight Around the Moon" "Stations of the Moon"
	a-j Develop the following vocabulary: phase, rill, gravitation, weight, mass, inertia, ellipse, rotation, orbit, satellite.
a. The moon is a very large ball of rocky material that revolves around the earth.	a1. Collect and discuss pictures and news articles related to recent space explorations concerning the moon.
b. The moon keeps revolving around the earth because two forces (gravity and inertia) are acting on it at the same time.	b1. Write a report on Newton's Laws of Inertia and Gravitation.
c. The moon revolves around the earth about once each month.	c1. Plot and discuss the orbit of a satellite around the earth.
d. The shape of the moon's orbit is an ellipse.	d1. Show the shape of the moon's orbit by using a piece of paper, a pencil, a ruler, two thumbtacks, and a piece of string about a foot long. Place the thumbtacks firmly on the paper about an inch or two apart. Tie the ends of the sting to make a loop. Put the loop around the thumbtacks. With your pencil inside the loop, tighten the

CONCEPTS	ACTIVITIES AND RESOURCES
	string. Keep the string tight and move the pencil's point around the thumbtacks until the starting place is reached. The line formed represents an ellipse.
e. Conditions on the moon are related to its mass. (It has about 1/6 of the gravity of the earth)	e1. Have each child figure out his weight if he were on the moon. Divide the child's weight by 6 to arrive at his "moon weight."
f. The moon may once have been a part of the earth.	f1. Have the children write a report on the George Darwin theory of how the moon was formed. Have them list possible ways to prove this theory.
g. The same side of the moon always faces the earth.	g1. One boy or girl is the "earth." Another boy or girl is the "moon." The moon boy walks around the earth boy. As the moon boy revolves, he never lets the earth boy see his back.
h. The moon is a non-luminous body.	h1. If possible observe a lunar eclipse. Make your own lunar eclipse by placing the globe between a light source (the sun) and another object (the moon) to show that when the light is unable to reach the moon it is not luminous.
i. The moon only appears to change its shape from week to week; in reality, it is always round like a ball.	i1. Set up a globe to be the earth. Darken the room. Use a ball as the moon. Let the filmstrip projector represent the sun. Shine the light onto the globe. Move the "moon ball" around the earth. Have a friend near the globe of the earth. Have him describe what he sees.
j. The moon goes through four phases in a period of about one month.	j1. Observe the phases of the moon. Keep a record of the various phases.

THE PLANET EARTH

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-i See T.E., Today's Basic Science 5, Harper and Row, 1967 pp. 129-151.
	a-i See T.E., Concepts in Science 5, Harcourt, Brace and World, 1966, pp. 48-67.
	a-i See T.E., Science in Our World 5, D.C. Heath, 1968, pp. 412-427.
	a-i Use the following filmstrips: "Night and Day" "The Earth, Our Earth" "The Solar System" "The Earth in Space" "Measuring Time by the Sun and Stars"
	a-i Develop the following vocabulary terms: atmosphere, lithosphere, hydrosphere, orbit, rotation, revolution, hypotheses, sphere, gravitation, protoplanets.
a. Scientists do not agree on the various hypotheses concerning the origin of the earth.	al. Develop a chart to show possible hypotheses of earth's origin, their strengths, weaknesses and possible tests of proof.
b. The earth is a planet in the solar system.	bl. Have the class make paper models of the planets in the solar system. Color the models and give each one appropriate identifying characteristics, such as rings around saturn, and polar ice caps on Mars, etc.
c. The earth is a sphere.	cl. Explore the globe and collect space pictures of the earth.
d. The earth is always turning (rotating).	dl. Use a teacher's swivel chair, wastebasket, string, meter stick, and a metal weight. Place the wastebasket on the chair and suspend the weight attached to the string from the meter stick resting across the top of the wastebasket. Start the weight

CONCEPTS	ACTIVITIES AND RESOURCES
	swinging in a north-south direction and slowly rotate the chair. Note that the pendulum continues to swing in a north-south direction. By comparing the rotating chair to the earth, the students might now be able to see how this experiment provides evidence that the earth rotates on its axis. (Report on Jean Bernard Foucault)
e. The earth revolves around the sun in a path called an orbit.	el. To distinguish between revolve and rotate make a sign marked "sun" and one marked "earth". Pin each sign on a child. Ask the child marked "earth" to walk around the child marked "sun." Have the "earth" keep turning as he walks around the "sun."
f. Day and night are a result of the rotation of the earth and the effect of the sun's rays.	fl. Shine a flashlight on the Northern Hemisphere of the globe. Be sure the flashlight beam covers all of the Arctic Circle. Rotate the globe. Does the Arctic Circle remain in the light through a complete rotation? Find St. Paul on the globe. Put a dab of clay at St. Paul. Rotate the globe. Be sure to keep the North Pole in the light through a complete rotation. Does St. Paul remain in the light through a complete rotation?
g. The time it takes for the earth to orbit our sun is a year.	gl. Have the children do research and use this information to make up a class chart on the planets and their times of revolution around the sun.
h. The earth consists of three main parts--the lithosphere, the atmosphere, and the hydrosphere.	hl. Put the words atmosphere, hydrosphere, and lithosphere on the chalkboard. Discuss their etymologies and give examples of each.
i. Gravitation is a force pulling objects toward the center of the earth.	il. Make a chart of the surface gravities of the various planets and determine your own weight on these planets. Use the chart on the following page.

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CONCEPTS	ACTIVITIES AND RESOURCES

Planet	Surface Gravity	Your Weight
Mercury	0.4	
Venus	0.9	
Earth	1.0	
Mars	0.4	
Jupiter	2.6	
Saturn	1.2	
Uranus	0.9	
Neptune	1.1	
Pluto	?	?

E.S.S. UNIT

ROCKS AND CHARTS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-f See Teacher's Guide for Rocks and Charts, McGraw-Hill Book Company, 1969.
	a-f Set of six filmstrips with teacher's manual; produced and distributed by Ward's Natural Science Establishment, Inc., P.O. Box 1712, Rochester, New York 14603.
	a-f Filmstips and records: "Rocks and Minerals - Parts I and II" "Weathering and Erosion" "Glaciation, Mountain Building, Earthquakes, and Volcanoes"
	a-f Films - See Teacher's Manual, p. 26.
	a-f Develop the following vocabulary words: anthracite, biotite, calcite and chalk, feldspar, galena, graphite, hematite, kaolinite, limestone, magnetite, marble, obsidian, pumice, quartz, sandstone, shale, slate, and talc.
a. Rocks differ in color. b. The weight of a rock depends on its size and density. c. The appearance of a rock will vary according to its composition. d. Rocks vary in their texture from rough to smooth. e. Rocks differ in degrees of hardness.	a-e Develop the following chart to study the characteristics and classifications of rock samples. These rock samples are available as a kit from Webster Division of McGraw-Hill Book Company.

Rock name	Color	Weight	Texture

Appearance	Hardness	Softness

Heading will differ with students as they independently develop their own charts.

CONCEPTS	ACTIVITIES AND RESOURCES
f. Rocks can be classified according to special tests.	f1. Use special tests such as the streak plate, vinegar, magnet, and electrical conductivity to further classify the characteristics of rock samples. For a complete description of these tests see the teacher's manual pp. 12-14.

GEOLOGY

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-dd See T.E. Today's Basic Science 5, Harper and Row, 1967, pp. 129-151.
	a-dd See T.E. Concepts in Science 5, Harcourt, Brace and World, 1966, pp. 1-22, 152-171.
	a-dd See TE Science in Our World 5, D.C. Heath, 1968, pp. 542-590.
	a-dd Show filmstrips; "Rocks and Minerals Parts I and II" "Weathering and Erosion" "Glaciation, Mountain Building, Earthquakes, and Volcanoes" "Conservation" "Nature Cooperates with Man" "Waste of our Resources" "Need for Conservation" "Soil Resources" "Forest Resources" "Wildlife Resources" "Water Resources" "Mineral Resources" "Terrestial Ecology" "Volcanoes, Geysers, and Hot Springs"
	a-dd Develop the following vocabulary words: Archeozoic, atmosphere, Azoic, Cenozoic, fault, folding, fossil, geophysics, hydrosphere, lithosphere, Mesozoic, Paleozoic, planetesimal, Proterozoic, magma, volcanoes, earthquakes, glaciers, lichens, sedimentary, metamorphic, erosion, water table, levees, artesian wells, fuels, minerals, metals, eras, ecology, conservation.
a. Scientists do not agree on the various hypotheses concerning the origin of the earth.	a1. Have children do research on theories of the earth's origin and discuss.
b. The solid part of the	b1. Cut a rubber ball in half. Label and color

CONCEPTS		ACTIVITIES AND RESOURCES	
	earth is called lithosphere and consists of three layers: the core, the mantle, and the crust.		the three sections of the earth.
c.	The composition of the earth's rocks is determined by the manner in which they were formed. These three classifications are igneous, metamorphic, and sedimentary.	cl.	Find and display samples of the three types of rocks. Discuss the classifications and reasons why they could be classified in this manner.
d.	Depending upon the degree of heat, pressure, and chemical change, rocks are formed within the earth or from sediments.	dl.	Place soil samples in a jar of water and stir. Allow to settle. Discuss the layering of soil and compare this to sedimentary rock.
e.	Sediment if formed by materials that settle to the bottom of the sea - rocks, seashells, skeletons of sea animals, sand pebbles, etc.	el.	Collect samples of fossils in the neighborhood or take a field trip to the banks of the Mississippi River in St. Paul.
f.	The earth's crust is made of several layers of rocks composed of minerals.	fl.	Use special tests such as the streak plate, vinegar, magnet, and electrical conductivity to determine the presence of certain minerals within a rock.
g.	Rocks may be classified according to their formation, mineral content, texture, color, hardness, crystal form, and specific gravity.	gl.	Make a chart to classify a group of rock samples according to their characteristics.
h.	The earth is in constant change as a result of heat, wind, water, plants, and pressures.	hl.	Take the children on a tour of the playground. Pick out as many examples of change in the earth's surface as possible. Try to determine the causes and classify them accordingly.
i.	Heat and pressure generated within the earth	il.	Mix up plaster of Paris, pour into a plastic bottle and place a cap on the bottle.

GRADE FIVE

CONCEPTS		ACTIVITIES AND RESOURCES	
	result in changes of its surface through volcanic and earthquake action.		Lay the bottle on its side and punch a hole in it. Push down on the bottle. Observe the mixture as it rises out of the hole. Allow to dry. Compare it to a volcano.
j.	Weathering and erosion break down the hardest rock into soil.	j1.	Heat a rock (try the more crumbly kind such as schist, for quicker results) so it will sizzle when plunged into cold water. Minute particles of material will be seen floating through the water as the rock cools.
k.	The top leyers of the earth's crust consist of soil.	k1.	Go to an excavation, gravel pit, or road construction area and observe soil profile found there.
l.	Geologists are scientists who learn about the earth's history by studying fossils and rock formations.	l1.	Save all the bones from a chicken leg. Then try to reassemble them.
m.	A fossil is the remains or traces of an animal of the past.	m1.	Mix some plaster of Paris in an empty coffee can. Pour the mixture into the cake pan. Press shells, leaves, and twigs into the mixture, them remove them. Allow the plaster to harden. Prints are left in the plaster.
n.	The adaptations of an animal to its environment can be understood by relating bone structure to the functions served.	n1.	Write to the Dinosaur National Monument, Vernal, Utah, for excellent and inexpensive pamphlet material on fossil life of the dinosaur era. For the address of the museums nearest your school, write to the American Association of Museums, Smithsonian Institute, Washington, D.C. 20025.
o.	Structural adaptations to environments of the past occur slowly.	o1.	Have the children trace the changes of one organism, the horse, as it has adapted over a time span of sixty million years. They infer that structural changes interact with changes in the environment.
p.	Sedimentary deposits indicate age of fossils.	p1.	Stack newspapers to a thickness of 15 inches. From top to bottom of the stack represents 150 million years on a scale of 1" equals

CONCEPTS	ACTIVITIES AND RESOURCES
	10 million years. This model may be used to study eras of geologic history.
q. The single celled organisms that developed in the early seas gave rise to the many-celled organisms of later eras; adaptation to the environment produced more complex structures.	ql. Make a geologic calendar divided into six eras, or spans of time. Start with the simplist life forms and expand up to the most complex form of life. List reasons for structural adaptations.
r. Gradual changed of structure in water animals of the ancient seas adapted them to land living.	rl. Introduce tides and their effect on the waters of the oceans. Look up tide tables from newspapers or an almanac. Ask questions concerning how tide water animals would have to develop adaptations in order to survive between tides.
s. The mammals have been more successful in their adaptations than have other forms of life.	sl. Keep a temperature record of your temperature, the room temperature, and the temperature of a reptile. If necessary place the reptile in a refrigerator in a cloth sack for 20 minutes or so. Compare the reptile's temperature, a child's temperature and the room temperature.
t. To conserve something means to use it wisely without wasting it.	tl. Find an area of a child's yard or part of the school yard where erosion is taking place. Work out a plan to prevent further erosion. If possible, actually try out your conservation project.
u. Ore is a mixture of rock materials which contain one or more useful minerals and usually contain metals.	ul. To find out how some metals are seperated from their ore by the flotation process, try the following experiment. Obtain some fine bronze or aluminum powder from a hardware or paint store. Mix the powdered metal, some course sand, water, and cooking oil in a screw-top jar. Shake the contents thoroughly. Set the jar aside for a while. Note what happens when the oil seperates from the water.
v. Places where ore is found are called fields, beds, pockets, veins, and lodes.	vl. Mix some sand and powdered clay, or a piece of old brick crushed with a hammer. Then mix in some of the following materials: iron filings, bits of solder, small pieces

CONCEPTS	ACTIVITIES AND RESOURCES
	of wire, small tacks or brads. Pour a cupful of the mixture into a quart jar half filled with water. Shake it well and let the sediment sink. Observe and discuss the settled layers and compare this to how ores are found.
w. Valuable minerals such as coal, oil, uranium, iron, etc.,are used by man to maintain and improve his way of life.	w1. Make a chart using collected ore samples and materials used in your homes made from the metals contained in these ore samples. w2. Heat a half filled test tube of powdered coal over a burner. Have a rubber stopper and a glass tube in the end. As you heat it, ignite the gas escaping from the glass tube. Allow the tube to cool. Examine the contents by breaking. The dark liquid is coal tar and the substance remaining in the tube is coke. Make up a coal products chart.
x. Coal was formed underground from plants that were covered and pressed down under the earth's surface for millions of years.	x1. Have a group of children construct a cross section of a coal forming swamp. In this the lowest level would be a black layer representing a coal bed already formed. It could be of clay and black paint. The various stages of coal could be shown--bituminous to lignite to peat, as the swamp progresses upward. This could finish with the surface exhibiting trees (made of sponge or cardboard), many already falling into the swampy water.
y. Scientists believe that oil was formed from dead sea animals and plants by the pressure and heat layers of sediment, by the action of bacteria, and by other forces.	y1. To demonstrate that all animals and plants contain oil, try the following experiments. Rub a peanut on a sheet of brown paper. Squeeze a piece of fresh orange or lemon peel over a sheet of brown paper. Squeeze the orange or lemon peel near a lighted candle. Put some shelled nuts in a plain paper bag. Observe the resulting oil spots. Discuss the relationship between these oils and how oil is possibly formed in the earth.
z. There are several kinds of nuclear fuels, but all began as uranium ore.	z1. Have the children do library research on nuclear fuels and their use by man. Contact Northern States Power and arrange

CONCEPTS	ACTIVITIES AND RESOURCES
	for a guest speaker to talk on the subject of nuclear power plants.
aa. Some iron ore may have been formed by the chemical action of bacteria.	aa1. Read p. 344 in *Science in Our World 5*, D.C. Heath, 1968. Obtain additional information about iron ore formation from the Minnesota Iron Mining Industry.
bb. Water is a very valuable resource. While very useful to man it can be very harmful and damaging.	bb1. Make a chart showing the constructive and destructive effects of water.
cc. Plants and leaves, while building up soil, also help to prevent erosion.	cc1. Cover three boards with soil. Leave one with soil exposed, place sod on one, and leaves over the other. Sprinkle water over the surface of the slanted boards. Observe the runoff collected in a pan.
dd. In order to maintain our natural resources, everyone must help through the conservative use of our natural resources.	dd1. Make a poster showing renewable and nonrenewable resources. Investigate different problems concerning their use and how their misuse will effect the future.

OCEANOGRAPHY

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-o See T.E., Today's Basic Science 5, Harper and Row, 1967, pp. 152-172
	a-o Develop the following vocabulary: aqualung, bathyscaph, bathysphere, bends, copepod, decapod, density, diatom, fathom, hydrameter, invertebrate, luciferin, luminescence, oceanography, phytoplankton, plankton, refract, scuba, snorkel, spicule, spongin, thermocline.
a. Scientists use special tools and equipment to explore the ocean depths.	a1. Show film, Oceanography: "Science of the Sea."
b. Oceanographers use their devices to take water samples, analyze sediment, gauge ocean currents, and measure temperatures.	b1. Visit a pond and take water samples, sediment samples, and temperature readings at different depths. Construct a chart showing the different observations.
c. A watertight diving suit protects deep-sea explorers.	c1. Have a child bring in scuba diving equipment or arrange for a resource person to come to the class and explain the operation of such equipment. Compare this to a deep-sea diving suit.
d. The "bathyscaph" and "bathysphere" can be looked upon as underwater laboratories.	d1. Prepare an overhead transparency showing the exterior and interior parts of a bathyscaph.
e. A measurement of the depth of the water is known as "sounding."	e1. Contact a sporting goods store and have them demonstrate the use of sounding equipment to find lake depths.
f. A diver must overcome many problems to explore the sea.	f1. Show film, "Matthew Fontaine Oceanographer."

CONCEPTS	ACTIVITIES AND RESOURCES
g. Among problems confronting the diver are water pressure, distorted vision, and temperature of the water.	g1. To show that depth affects water pressure, use a hammer and a large nail to punch three holes along one side of a tall tin can. One hole should be near the top, one in the middle, and one near the bottom. Fill the can with water and keep it full by adding water as it runs out. Compare the distance water shoots out of the three holes.
h. A diver must overcome the pressure of both air and water when he drops into the ocean depths.	h1. Read text pp. 231-236, Today's Basic Science, Harper and Row, 1967
i. The ocean contains minerals. The most common is salt.	i1. Make a circle graph to show the percentages of minerals in seawater. Collect this information by doing library research.
j. Minerals are washed into the ocean from soil and rocks as well as by volcanic action.	j1. With a can opener, remove the top and bottom of a tin can. Cover one end of the can with a piece of cotton cloth or several layers of cheese cloth, and fasten the cloth securely to the open end of the can. Fill the can with crushed limestone and while holding the can over a shallow saucer, pour distilled water or freshly collected rain water into the can. Collect a sizeable quantity of the water that has passed through the can and fallen into the saucer. Allow this to evaporate. Observe the deposit.
k. Ocean water can be purified; the salt can be removed.	k1. Mix a solution of salt and water. Taste the solution. Be sure it is salty. Pour the solution into a teakettle. Boil it. Observe the water vapor rising from the spout. Hold a piece of glass in the path of the vapor. Collect the condensed water in a glass. Taste the collected water for salt content.
l. Many plants and animals live in the sea.	l1. Collect pond water and observe it under a microscope. Note different plants and animals.

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CONCEPTS	ACTIVITIES AND RESOURCES
m. Tiny plants and animals of the sea are known as plankton.	ml. Set up a seawater aquarium. Observe the growth of plankton.
n. A "diatom" is a single-celled plant that grows in the ocean.	n-o Study samples of water from the sea water under a microscope and attempt to identify "diatom" and "copepod."
o. The "copepod", a small animal of the sea, goes through an incomplete metamorphosis.	

E.S.S. UNIT

BALLOONS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-g See Teacher's Guide for *Balloons*, McGraw-Hill Book Company, 1968.
a. Air weighs nothing when weighed in air, regardless of the volume weighed. Air under pressure, however, has weight when weighed in air.	al. Weigh plastic bags first empty and then filled with air. Use paper clips as your unit of measure. Then weigh a football or very large balloon inflated to various pressures. Compare weights and draw conclusions.
b. A balance is used to weigh things.	bl. Present worksheet number 1. Have children follow along on the construction of a balance. To prepare the children for the use of the balance present worksheets 2-4.
c. Gases such as carbon dioxide, oxygen and hydrogen may be produced through the mixture of various substances.	c-g See teacher's guide for, *Balloons*, McGraw--Hill Book Company, 1968, pp. 13-31.
d. Various tests may be performed on gases to determine their properties.	
e. Gases will have different weights depending on the composition of the atmosphere they are weighed in.	
f. The weight of equal volumes of a substance is determined by density of the substance.	
g. The weight a solid loses in a liquid is equal to the weight of the liquid it displaces.	

WATER, WEATHER, AND AIR

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-s See T.E., *Science in Our World 5*, D.C. Heath, 1968, pp. 394-411.
	a-s Show filmstrips: "Sun, Weather Maker" "Air in Action" "Water in Weather" "Thunderstorms, Weather, and People" "Weather Bureau" "Weather Maps" "Be Your Own Weather Man"
	a-s Develop the following vocabulary: meteorologist, atmosphere, thermometer, thermograph, prevailing and trade winds, anemometer, windvane, calibrating, Beaufort scale, front, barograph, humidity, stratus, cumulus, alto, nimbus, hygrometer, dew point, precipitation, radar, hurricane.
a. Weather is important to all of us.	a1. Have each member of the class describe one particular day when weather made a change in his plans.
b. The U.S. Weather Bureau makes forcasts from reports received from all over our country and other parts of the world.	b1. Plan a class field trip to the weather bureau.
c. One weather consideration is air temperature, which in this country is measured in degrees Fahrenheit.	c1. Learn to change Fahrenheit to Centigrade. See T.E., *Science in Our World 5*, D.C. Heath, 1968, p. 399.
d. A record of the normal temperature range in the past may help to predict the temperature of a similar time in the future.	d1. Check your local paper for monthly charts of weather information including average temperatures, and record highs and lows.

CONCEPTS	ACTIVITIES AND RESOURCES
e. Winds, which are currents of air, are caused by differences in temperature and pressure.	e1. To show that unequal heating produces winds, get a large shoe box, cut out a large rectangular hole in one side of the box and cover it with cellophane. Cut two holes in the top of the box. One near each end. Open the box and place a lighted candle beneath one hole. Place a lamp chimney over each hole. Produce smoke directly over the chimney that does not have the candle under it. The smoke will be carried down the chimney, across the box, and up the other chimney.
f. High temperature at the equator and low temperature near the poles cause currents of air to flow northward and southward.	f1. To show the earth is unequally warmed by the sun put the same amount of soil into two cardboard boxes. Place both boxes in the sunlight. Let one lie flat so it receives slanted rays from the sun, and prop up the other box so that the sun's rays strike it directly. Place thermometers that have the same reading into each box, inserting both thermometers into the same depth of soil. Take temperature readings every 10 minutes. The soil that receives the direct rays of the sun will become warmer. Compare this to the relationship between the sun and the earth.
g. In some parts of the earth the air moves little for long periods of time. Such places are breeding grounds of air masses.	g1. Study the air masses chart p. 8 of *Science in Our World 5*, D.C. Heath, 1969.
h. The atmosphere (air blanket surrounding the earth) is several hundred miles deep.	h1. Have the children make a drawing showing the atmospheric layers.
i. The pressure of air is caused by its weight. At sea level the air pressure is usually about 15 pounds per square inch.	i1. Make a water barometer. See p. 17 of *Science in Our World 5*, D.C. Heath, 1968.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
j. Dry air is heavier, and has greater pressure than moist air.	j1. Keep a chart of barometric readings and weather conditions over a long period of time. See pp. 22-23 of *Science in Our World 5*, D.C. Heath, 1968, for directions on how to build a hygrometer.
k. We can often tell about the coming weather by the kind of clouds which appear.	k1. Obtain cloud charts available at some local banks and study clouds each day comparing them, naming them, and observing the weather that accompanies them.
l. When water on the earth's surface is heated, it evaporates and becomes water vapor (a gas).	l1. Put 10 drops of water in each of two pie tins that are the same size. Put one tin in the sun and the other in the shade. The water will evaporate more quickly in the heated tin because the water molecules move faster, and thus more molecules can leave the water at one time.
m. When water vapor is cooled it condenses around tiny specks in the air and forms tiny drops of water.	m1. Make a fog by filling a milk bottle with hot water (slowly). Then empty out most of the water. Leave only about 2 inches in the bottom. Put an ice cube on the mouth of the bottle and hold the bottle between you and the sunlight. A fog will form in the bottle as the warm humid air is cooled by the ice.
n. Knowing the amount of moisture (humidity) in the air helps us to forecast the weather. We measure the humidity with hygrometers.	n1. Use a sling psychrometer to obtain wet and dry bulb readings of temperature. Use a chart and teach children how to figure relative humidity.
o. The temperature at which water vapor in the air will condense and form into droplets of water is called the dew point.	o1. Determine the dew point by doing the following experiment. fill a can three-fourths full of slightly warm water. Take the temperautre of the air in the room and write it down. Put the thermometer in the water in the can. Add a few pieces of ice at a time,and stir. Keep adding and stirring. As you do this watch the outside of the can carefully. Read the temperature of the water at the moment when a mist begins to form on the can. This is the dew point of the air at the time and place of the experiment.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
p. Precipitation is a word for the several forms in which water comes back to earth (rain, snow, sleet, and hail).	pl. Discuss reasons for different forms of precipitation.
q. To forecast the weather more accurately and for greater periods of time, it is necessary to know the weather conditions high up in the air as well as near the ground.	ql. Release several helium filled balloons. Attach post cards addressed to your school. With luck one may be returned. This will show wind patterns.
r. Artificial satellites contain several kinds of instruments to record information useful to weather forecasters.	rl. Obtain a chart of space flights and study those dealing with weather forecasting.
s. A combination of several special weather conditions can develop into a violent storm called a hurricane.	sl. Show film, "Hurricane Circuit".

E.S.S. UNIT

BUDDING TWIGS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
a. A home-made dissecting scope may be constructed by using simple materials.	a-f. See Teacher's Guide, Budding Twigs, Elementary Science Study of Education Development Center, Inc., 55 Chapel Street, Newton, Massachusetts, 02160.
b. Pruning a tree, if it is done with reasonable care, will not harm a bush or tree and may, indeed, benefit it.	
c. Buds on twigs differ in number, position, and arrangement.	
d. The development of the buds reveals growth characteristics; the placement of leaves in relation to flowers, the sequence of leaf or flower appearance, and the diversity of structures on one specimen.	
e. Twigs have certain identifying characteristics including the bark, its variations of color, texture, and openings, and other external structural features, such as leaf scars, thorns, hairs, and spikes.	
f. A cross-section of a branch will show concentric rings.	

PLANTS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-r See T.E., Today's Basic Science 5, Harper and Row, 1967, pp. 105-128.
	a-r See. T.E., Concepts in Science 5, Harcourt, Brace, and World, 1966, pp. 70-93, 110-133.
	a-r See T.E., Science in Our World 5, D.C. Heath, 1968, pp. 526-541.
	a-r Suggested filmstrips: "Structure of Plants" "Plants Are Living Things" "Work of Flowers" "Seeds and How They Travel" "How Plants Start Growing" "How Plants Help Us"
	a-r Develop the following vocabulary: angiosperm, anther, auxins, bryophyte, calyx, cell,chlorophyll, corolla, cytoplasm, fertilization, fungi, geotropism, gymnosperm, hormone, lichen, nucleus, organ, ovary, ovule, photosynthesis, pistil, pollination, properties, protoplasm, pteridophyte, sepal, spermatophyte, spore, stamen, stigma, style, system, thallophyte, tissue.
a. All plants and animals are made up of cells; the cell is the unit of structure and function of living things.	a1. Show film, "Cell - Structural Unit of Life."
b. Plant and animal cells have basically similar structures.	b1. Examine commercially prepared cells under a microscope. Draw models and define parts and functions. Explain that the one difference between plant and animal cells is that plant cells have cell walls consisting of cellulose and animal cells do not have cell walls.
	b2. Use a hen's egg as a model of a large cell.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	Point out that the egg nucleus spot can be considered the nucleus, the yolk and the white the cytoplasm, the membrane encloses the yolk and white, and that protoplasm is considered as all the living material.
c. Protoplasm, the living material in the cell, is composed of elements and compounds in the earth's crust and atmosphere. There is a flow of matter and energy between the organism and the environment.	c1. Complete the investigation into testing for compounds in protoplasm as described on p. 183, *Concepts in Science 5*, Harcourt Brace and World, 1966.
d. A single-celled organism performs all the life functions within the cell; a many-celled organism is a community of interdependent cells.	d1. Examine pond water under a microscope. Compare what you see to pictures of single-celled animals. Explain that single-celled plants and animals are complete organisms.
e. Growth in a many-celled organism consists of multiplication and differentiation of cells.	e1. Trace the development of a frog's egg to maturity. e2. Put water into one jar until it is about one-quarter full. Dissolve two lumps of sugar in the water. Lightly cover a dime with yeast powder. Put this amount of yeast into the jar of sugar water. Screw a cap loosely on the jar. Leave the jar at room temperature for 4 days. Strain the yeast mixture through a closely woven cloth into another jar. This will filter out the yeast cells. Let them dry overnight. Compare them with the amount of yeast you started with.
f. The pattern of the organism is passed along to new cells by duplication of chromosomes and their DNA content.	f1. Have a child read and report on the work of the Italian scientist Spallanzani.
g. New plants are produced by similar living mature plants through seeds, bulbs, tubers, spores, or cuttings.	g1. Obtain examples of the various types of reproductive plants. Set up a display and observe how each reproduces.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
h. A botanist classifies a plant by its structure. This may be green or non-green, plants with seeds or without seeds, or as plants with tubes and plants without tubes.	h1. Prepare a chart for classifying plants. Use the form on p. 112 of Today's Basic Science 5, Harper and Row, 1967.
i. Non-green plants do not contain chlorophyll and cannot make their own food; they must get their food from other living or once living things.	i1. Moisten a piece of bread, then leave it in the air for a while. Next put the damp bread into a dark place for one week.
j. Green plants contain chlorophyll. This gives them their green color, and permits the process of photosynthesis to take place.	j1. Green plants contain chlorophyll. Obtain the water plant elodea from a store that sells aquarium supplies. Examine a leaf of elodea under the microscope and the green chlorophyll bodies present. You can extract chlorophyll from a green leaf by first boiling the leaf in water for several minutes to break down the plant cell walls. In winter a spinach leaf can be used. Prepare a double boiler with water in the bottom section and rubbing alcohol in the upper section. Place the leaf in the alcohol and heat the double boiler until the water boils, and them continue to boil for 10 to 15 minutes. The hot alcohol will extract the chlorophyll.
k. Photosynthesis uses the energy of sunlight and the action of chlorophyll to cause a chemical reaction that changes carbon dioxide and water into sugar, and some more complex foods.	k1. Can plants use color in light? Plant some radish, bean, or grass seeds in four cardboard containers. Let the seeds sprout. Then cover one box with red cellophane another with green and the third with blue. Do not cover the fourth box. Place the boxes in sunlight or use a daylight florescent lamp. Keep a record of the plant changes.
l. Living things obtain from one another and from the environment the matter and energy they need for growth and activity.	l1. Have the children draw pictures showing the interdependence between plants and animals.

CONCEPTS	ACTIVITIES AND RESOURCES
m. The roots of higher plants help support the plant and absorb water and dissolved minerals from the soil.	ml. Pour a small quantity of water into the dish. Put the sponge on the water. Lay the Lima bean seeds on the moist sponge. Observe the seeds for a period of several weeks. Make a record of what you see.
n. The stems of higher plants help support the plant and transport water, dissolved minerals and food materials.	nl. Get a potted plant. Place it on its side toward the window. Get another plant and set it erect near by. Observe what changes occur in the growth of the stems and branches of the plant on its side. What is happening? Do you observe any changes in the plant that is standing erect.
o. In higher plants most of the photosynthesis takes place in the leaves. The arrangement of the leaves generally enables them to receive the maximal amount of solar radiation.	ol. Light affects plants and their growth in a number of ways. For example, the stem of a plant bends toward the light. Light also enables the plant to make its own food. Get two chrysanthemum plants. Mark one Plant A and the other Plant B. Place Plant A in the sun. Leave it there. Put Plant B in a dark room for part of each day. Keep a record of the number of hours during which each plant was exposed to light. Which plant came into bloom first?
p. Flowers are organs of reproduction.	pl. Obtain a large picture of a flower showing its function in reproduction. Examine a real flower or watch a plant such as a pine tree produce its seed.
q. Bees and other insects help plants to make seeds by transferring pollen from one flower to another.	ql. See experiment on page 190, Today's Basic Science 5, Harper and Row, 1967.
r. Bacteria are single-celled plants with cell walls; they do not have a nucleus or chlorophyll.	rl. See page 537 of Teacher's Edition, Science in Our World 5, D.C. Heath, 1968.

E.S.S. UNIT

ANIMALS - POND WATER

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
a. A pond contains a fantastic collection of life. A random bucketful of mud, sticks, and water will prove to contain a myriad of organisms--worms, tiny crustaceans, insect larvae, snails, perhaps even a tadpole or two. Pond Water introduces children to this exciting array of living creatures, invites them to make their own collection on field trips, distinguish their finds through observation and description, and go on to study the tiny animals they have collected. Through their work with Pond Water, children will learn to look more closely at the world around them. They can begin to understand the complicated interactions of pond life. And most important, they will learn to use their eyes and their minds to find out about the world in which they live. For richest collections, this unit is best taught beginning in spring or early fall, when ponds are teeming with life. Some pond life can be found at any time of year, even under the winter ice.	a1. See Teacher's Guide, Pond Water, McGraw--Hill Book Company, 1968.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
The study should take at least five or six weeks, though generally it has gone on much longer. At the beginning, it is advantageous to have daily classes of at least 40 minutes each. Later meetings can be spaced out to two or three times a week, to allow children to observe changes in their aquariums. The class may also want to consider such ESS units as *Eggs and Tadpoles* and *Small Things*.	

E.S.S. UNIT

ANIMALS - SMALL THINGS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
a. With Small Things, students are introduced to the microscopic world, to the instruments needed to make it accessible, and to the appearance and structure of living and nonliving things. Children are encouraged to question and to use both mind and hands to arrive at some answers. Answers come from the student's own observations, comparisons, and generalizations. The unit is organized into a series of eleven investigations. In the course of these investigations, children learn to use new equipment and skills--they become acquainted with their own microscopes, learn to make slides and to stain specimens. The microscope provided in the 6-Student Kit was specially designed so that all working parts are exposed and can be easily observed by the students. This unit is recommened for use with Grades 4-6, though it is possible to teach some of the activities in the lower grades. The amount of time required for this unit will vary widely from class to	a1. See Teacher's Guide, Small Things, McGraw-Hill Book Company, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES
class, since there is no predetermined time span for any of the activities. Some classes may want to spend several weeks examing pond water and looking at protozoa. Others will be more interested in crystals. In general, classes need from six to 10 weeks to complete the unit.	

E.S.S. UNIT

ANIMALS - BEHAVIOR OF MEALWORMS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
a. Behavior of Mealworms stimulates children to ask questions about the observable behavior of an unfamiliar animal and then directs them to ways of finding the answers for themselves. As children observe and experiment, they learn some things about the process of scientific inquiry. Mealworms are convenient subjects for experimentation since they exhibit reasonably consistent and definite behavior. They are clean and odorless, require practically no care, and can be purchased very inexpensively from a number of sources. The students begin their study of mealworms with undirected observations. A multitude of questions arise, such as: Can a mealworm see? What do they eat? How do they find their food? Can a mealworm be made to back up? In their attempts to solve these problems, the students devise experiments observe, measure, keep records, design and build equipment, and draw conclusions.	a1. See Teacher's Guide, Behavior of Mealworms, McGraw-Hill Book Company, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES
The children will also be interested in the two supplementary reading selections, *How Barn Owls Hunt* and *How a Moth Escapes from Its Cocoon*, described below. This unit has been taught most frequently to sixth-grade classes, but can be used sucessfully in Grades 4-8. To cover all activities, you will need 25-30 class periods.	

ANIMALS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-g See T.E., Science in Our World 5, D.C. Heath, 1968, 504-525.
	a-g Suggested filmstrips: "Learning About Mammals" "Learning About Birds" "Learning About Amphibians" "Learning About Reptiles" "Learning About Insects" "Some Water Animals, Woodland Friends"
	a-g Develop the following vocabulary words: vertebrates, invertebrates, fish, amphibian, reptile, bird, mammal, cold-blooded, warm-blooded, scales, skin, protozoa, amoeba, paramecium, sponge, jellyfish, coral, worm, mollusk, starfish, arthropod.
a. Animals can be classified into two large groups, those with supporting internal structures, the vertebrates, and those without such structures, the invertebrates.	a1. Secure some vertebrae from several kinds of animals; for example, chicken, fish, and the neck bones of beef. Have the class examine each. Some of the more advanced students might clean and mount the skeletons of small animals. The flesh of the animal is easily removed if the animal is cooked in boiling water. As the flesh is removed from each body part, the students should make drawings of the positions of the bones and then place the bones in an envelope. When all the bones have been cleaned, they can be mounted on cardboard with glue. Fish, frogs, and toads are suitable animals for beginners.
b. Fish are vertebrates that have fins, are covered with scales, breathe through gills, and are cold-blooded. Most fish lay uncovered eggs in water.	b1. Set up an aquarium as a class project. b2. Observe part of the circulatory system of a fish under a microscope. Goldfish are recommended for this activity. The fish should be wrapped in wet gauze to prevent the drying of its skin and gills while the observation is being made. The tail is then placed in position on a glass slide under a microscope.

CONCEPTS	ACTIVITIES AND RESOURCES
	Do not keep the fish out of water for more than two minutes.
c. Amphibians are vertebrates that have gills and get oxygen from the water when they are young, have lungs and get oxygen from the air when they are grown, have a moist skin without scales, and are cold-blooded.	c1. Study the life cycle of the frog. Collect frogs' eggs from a pond during the spring and hatch them. Keep a picture record of their development.
d. Reptiles are vertebrates, are covered with scales, breathe air through lungs, and are cold-blooded. Most reptiles lay leathery-shelled eggs on land.	d1. Develop an animal kingdom chart for classifying animals according to such headings as type of body, how it gets food, where it lives, how it breaths, and general body characteristics.
e. Birds are vertebrates that have feathers, are warm-blooded, have lungs and breathe air, have bills but no teeth, have two wings and two feet, and hatch out of eggs.	e1. Illustrations of bird bills and feet and suggested activities may be found on page 513 in the Teacher's Edition of Science in Our World 5, D.C. Heath, 1968.
f. Mammals are vertebrates that are warm-blooded, have hair, can make milk to feed to their young, and breathe air through lungs. Most mammals give birth to live young.	f1. Keep several pets such as rats, gerbils, mice, hamsters, guinea pigs, etc. Have children care for them and report anything new to the class.
g. Most of the animals of the world are invertebrates. Included are protozoa, sponge, jellyfish, coral, worms, mollusk, starfish, crustaceans, centipedes and millipedes, spiders, and insects.	g1. A small sample of assorted pondweed in pond water will furnish you with a brood of several million paramecia in a matter of a week. Observe them under a microscope. g2. Examine a natural sponge. Obtain a natural sponge. Have the children observe the

CONCEPTS	ACTIVITIES AND RESOURCES
	many holes in the sponge. Let them feel the sponge, and then point out that this soft, flexible material is really the skeleton of the sponge. Have the children read about and report on how commercial sponges are collected and treated. g3. Encourage children to make collections of shells and insects.

PET ANIMAL BREEDING

ANIMAL ANIMAL	READY TO BREED FOR FIRST TIME	BABIES INDEPENDENT	GESTATION OR INCUBATION	NUMBER IN LITTER	READY TO REBREED
Hamster	2 months	weaned at 2 to 3 weeks	16 days	2-15	4 to 6 days after delivery (then return to babies)
Rabbit	8 months	weaned at 2 months	30-33 days	5-18	several days after litter is weaned
Mice	2-3 months	weaned at 4 weeks	20 days	5-15	after litter is weaned
Guinea pig	5-6 months	weaned at 3 weeks	63-70 days	1-6	after litter is weaned
Canary	1 year	3 weeks	13 days	4-5 eggs	3 weeks after hatching
Parakeet	11 months	5 weeks	18 days	3-7 eggs	4 mos. after hatching
Turtles					
painted	spring after birth	immediately	70-84 days	4-8 eggs	the following spring
spotted	spring after birth	immediately	82 days	2-4 eggs	the following spring
box	spring after birth	immediately	89 days	3-8 eggs	the following spring
Snakes					
live-bearers	spring after birth	immediately	several months		the following spring
egg-layers	spring after birth	immediately	2-3 months		the following spring
Frogs					
leopard	2 to 4 years	immediately	4 days-3 wks	5000 eggs	early each spring
pickerel	2 to 4 years	immediately	6 days-2 wks	2-3000 eggs	earlyeach spring
spring peeper	2 to 4 years	immediately	5 days-2 wks	1300 eggs	early each spring
green	2 to 4 years	immediately	3 to 5 days	several thousand	late each spring
bull	2 to 4 years	immediately	4 days	10-12,000 eggs	late each spring
Salamanders					
newt	spring after birth	immediately	3-5 weeks	200 eggs	each spring
spotted	spring after birth	immediately	4-7 weeks	100 eggs	each spring
marbled	fall after birth	immediately	all winter	100 eggs	each fall

CONCEPTS	ACTIVITIES AND RESOURCES

CONCEPTS	ACTIVITIES AND RESOURCES

E.S.S. UNIT

MATTER - COLORED SOLUTIONS

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
a. This unit utilizes food coloring, water, salt, and transparent containers to introduce children to ideas associated with density and the layering of liquids. Various liquids behave differently when added to one another, and the children soon begin to ask "why?" Why does one liquid sink into another? Why do some liquids stay on top of others if you don't shake them up? In time, the children develop a scheme for ordering the liquids they are exploring according to "weight for the same amount." After the children have become familiar with the basic materials--water, slightly diluted food coloring, transparent tubes, and eyedroppers, they go on to experiment with salt solutions, liquid "sandwiches," other common liquids, and some solids. Finally, the children are given an oppoutunity to pursue some research problems on their own, using the information they have mastered. Colored Solutions is best	a1. See Teacher's Guide, Colored Solutions, McGraw-Hill Book Company, 1968.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
suited for Grades 3-8. The unit may take anywhere form 12 to 20 class periods to complete.	

MATTER

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-k See T.E., Today's Basic Science 5, Harper and Row, 1967, pp. 191-208.
	a-k See T.E., Concepts in Science 5, Harcourt, Brace and World, 1966. pp.24-47.
	a-k See T.E., Science in Our World 5, D.C. Heath, 1968, pp.428-437.
	a-k Suggested Filmstrips: "What is an Atom?" "What is Matter?" "What is Chemistry?"
	a-k Develop the following vocabulary; matter, mass, molecule, atom, solid, liquid, gas, element, nucleus, neutron, proton, electron, compound, chemical and physical change.
a. Matter is the name given to everything that has weight and takes up space.	al. Have children make a list from group discussion of various ways of telling one thing from another (physical properities) such as: weight, volume, color, shape, texture, living, non-living, visible, invisible; etc.
b. Matter commonly exists as solids, liquids, and gases. The amount of heat in the substance determines its state.	bl. Place some ice cubes in a Pyrex container and allow them to melt. Then heat the water until it boils. Point out the changes in state that have taken place. Have the children make a list of familiar changes in state that take place around them.
c. The earth's matter is built up of atoms combined in many ways (elements, compounds mixtures).	cl. Place one or two teaspoonfuls of sugar in a test tube and set over a heat source. Observe the change.
d. The atom is the smallest whole piece of a particular element.	dl. See pages 287-292 of Today's Basic Science 5, Harper and Row, 1967.

CONCEPTS	ACTIVITIES AND RESOURCES
e. There are 103 different known kinds of atoms in the world (called elements).	e1. Make a collection of easily available elements such as iron, copper, silver, gold, aluminum, magnesium, tin, zinc, carbon, and sulfur. Point out that all the atoms of an element are the same, but the atoms of one element are different from the atoms of other elements. Divide the elements into two groups: metals and nonmetals. Make a list of all the properties that metals have in common. List some of the ways metals differ from each other. Compare the difference between metals and nonmetals.
f. The fundamental particles of the atom are the electron, proton and neutron.	f-h You can make a model of a helium atom. See page 293 of Today's Basic Science 5, Harper and Row, 1967.
g. Electrons revolve around the nucleus of the atom; the nucleus contains protons and neutrons.	
h. The electron has a negative charge; the proton a positive charge; and the neutron no charge at all.	
i. An element gets its atomic number from the number of protons its nucleus contains.	i1. Obtain a periodic table of elements and discuss the information contained in this chart.
j. There are two kinds of changes that can happen to matter: physical changes and chemical changes.	j-k Physical and chemical changes. Cut up a piece of paper or wood into small pieces, and then burn the paper or wood. Note that cutting the paper or wood is a physical change, but burning the material is chemical change. Compare the basic differences between physical and chemical changes.
k. In chemical or physical changes the total amount of matter remains unchanged.	

HEAT, MECHANICAL, CHEMICAL AND NUCLEAR ENERGY

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
	a-p See T.E., Today's Basic Science 5, Harper and Row, 1967, pp. 40-61.
	a-p See T.E., Science in Our World, D.C. Heath, 1968, pp. 428-465.
	a-p Suggested filmstrips: "What is Energy?" "Machines"
	a-p Develop the following vocabulary: energy, mechanical, oxidation, molecule, nuclear, fission, fusion, motion, work, power, chemical.
a. Energy can be defined as the ability or the capacity to do work. This energy comes in several forms: mechanical, heat, light, sound, magnetism, electrical, chemical and nuclear.	a-c Show the following films: "Energy at Work" "Energy and Work"--EB.
b. The amount of input energy is always equal to the amount of output energy.	
c. The law of conservation of energy states: "Energy cannot be created or destroyed; it can only be transferred from one form to another.	
d. Heat and temperature are different. (Heat is the energy produced by molecular motion.) Temperature is the	d1. Put eighteen drops of water into the test tube. Use the medicine dropper. The eighteen drops of water will equal about one gram. Measure the temperature of the water. Use the centigrade thermometer.

CONCEPTS	ACTIVITIES AND RESOURCES
measurement of the average molecular motion in a substance. Heat is measured in calories; temperature is measured in degrees.	Heat the water over the alcohol burner. Hold the test tube with a clamp. Be sure you have heated the water. Then measure the temperature again. How many degrees centigrade has the temperature risen? How many calories of heat were added to the water?
e. The molecules of most substances, when heated, move faster and farther apart, causing the substance to expand, or become larger. When these substances lose heat energy, they contract.	el. Get a dial-type thermometer. Take the thermometer apart. Examine the coil. What metals do you think the coil is made of? Use a match to heat the coil. Does the coil tighten or loosen when it is heated.
f. One of the most useful ways of getting work from heat energy is to transfer it to mechanical energy. An engine is a machine that changes energy--especially heat energy--into motion.	fl. For activities and explanations of this concept see chapter 3 in *Today's Basic Science 5*, Harper and Row, 1967.
g. Work is done when an object is pushed or pulled. Forces are pushes or pulls which can make things move, stop, or change directions. These forces are gravity, friction, magnetism, and mechanical energy.	gl. Use "Problems About Amounts" page 123 of *Science in Our World 5*, D.C. Heath, 1968.
h. All machines are made up of one or more of the elements of simple machines. There are six kinds of simple machines (pulley, screw, wheel and axle, incline plane, lever, and wedge.)	h-i Show the films, "Machines Do Work," and "Machines Help Us."

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
i. Machines make work easier by increasing force or by changing the direction or distance of force. The amount of work done by machines is a relationship between the force needed to move an object and the distance through which it moves.	
j. Matter can be changed physically or chemically through the use of energy. Physical change is a change in the size, shape, or state of matter. Chemical change is the change in the molecular structure in matter.	j1. Put ½ teaspoonful of bicarbonate of soda into half a cup of vinegar. Do you see a solid become a liquid? Does a gas come out of the liquid?
k. In every chemical change there is an energy transfer. High-energy substances can give off a great deal of energy; low-energy substances can give off little or none.	k-1 Make a visit to the heating plant in your school. Ask the custodian to explain how the heating system works.
l. The combination of oxygen with any substance is called oxidation. During oxidation heat energy is always given off.	
m. The energy we get from the nucleus of an atom is called nuclear energy. Nuclear energy can be released in two ways: by fission and by fusion.	m1. Have the children do library research on atomic energy on such topics as: Einstein, Fermi, Beegueral, nuclear fission and fusion.

GRADE FIVE

CONCEPTS	ACTIVITIES AND RESOURCES
n. All atoms have: 1. one or more electrons whirling around the nucleus; 2. one or more protons in the nucleus; 3. as many electrons as protons; 4. neutrons in the nucleus (except in the case of ordinary hydrogen.	n1. Draw diagrams of specific atoms labeling parts.
o. Scientists do not know the exact nature of the energy which keeps the nucleus together, but they have learned how to release it.	o1. Discuss the helpful and harmful affects of atomic energy. Areas of discussion include; agriculture, medicine, industry, power, ships, alpha,beta, and gamma rays. Contact Northern States Power Company and ask for a guest speaker to explain the workings of their new Monticello Nuclear Power plent to your class.
p. The law of conservation of mass-energy states that mass-energy can neither be created nor destroyed; it can only be transferred from one form to another.	p1. Refer to pages 140-143 of Science in Our World 5, D.C. Heath, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES

OUTER SPACE

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
a. Space is not truly "empty". It contains atomic particles and high-energy radiation.	a-k. See T. E., Today's Basic Science 6, Harper & Row, 1967, pp 68-87, 180-200
	a-k. See T. E., Concepts in Science 6, Harcourt, Brace & World, 1966, pp 176-197.
	a-k. See T. E., Science for Today and Tomorrow 6, D. C. Heath, 1968, pp 554-585.
	a-k. Show Filmstrips: "Man Studies the Sky", "The Milky Way,""Sky Patterns","Laws of the Sky", "The Earth in Space," "Time Space and Energy," "Hazards in Space Travel", "Measuring Time by the Sun and the Stars."
	a-k. Develop vocabulary terms; nuclear energy, telescope, radio telescope, spectroscope, galaxy, supernovas, Newton's laws of motion, theory, temperature.
	a1. Collect and study accounts of space flights, and their encounters with particles and radiation.
b. Nuclear reactions produce the radiant energy of stars, and consequent change.	b1. Develop a model drawing showing the concept of fusion of hydrogen into helium and the resultant energy.
c. The heat, temperature, and size of a star can be determined by analysis of its light.	c1. Turn on a hot plate and watch the colors of the heating elements change. Have students suggest hypotheses on how we can use light and color to gain information about the stars.
d. The Milky Way galaxy is vast in the number of stars and the distances between them.	d1. Have children attempt to take photographs of the stars using time exposure photography.

CONCEPTS	ACTIVITIES AND RESOURCES
e. Systems of stars may have formed from supernovas.	e1. Assign special reports on the Crab Nebula and Ursa Major.
f. The position of the stars changes in a predictable and orderly way.	f1. A price list of star photographs, wall charts, and a popular magazine, Sky and Telescope, is available from the Sky Publishing Corporation, Harvard College Observatory, Cambridge, Massachusetts 01922.
g. Astronomical distances are measured in light-years.	g1. Figure out the amount of time it would take for the light of the sun to reach the earth.
h. The invention of the telescope, radio telescope, and spectroscope have made possible an enormous increase in astronomical observation.	h1. Have children prepare reports on the telescope, radio telescope and spectroscope.
i. Anything in motion will move forever in a straight line with unchanging speed, unless a force slows it or otherwise changes its motion.	i1. Place a penny in a glass. Hold the glass in your hand in a horizontal position. Point the open end of the glass forward. Walk as fast as you can. Stop suddenly. Ask questions related to observations.
j. Scientists do not know whether space ends.	j1. Have a class discussion on their ideas and concepts of the universe.
k. Travel to and communication with other planetary systems will be extremely difficult.	k1. Make a wall chart and list difficulties that have been overcome or will have to be overcome in space exploration.
	a-k. Culminating Activity-attempt to arrange an evening field trip to a college observatory.
	a-k. Use EIS unit, "The Universe."

THE SUN

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-k. See T.E., Today's Basic Science 6, Harper & Row, 1967, pp180-200.
	a-k. See T. E., Concepts in Science 6, Harcourt Brace & World, 1966, pp 176-198.
	a-k. See T. E. Science for Today and Tomorrow 6, D. C. Heath, 1968, pp 554-585.
	a-k. Show filmstrips: "The Sun", "The Solar System," "The Stars," "Astronomy Through the Ages," "Our Sizzling Sun," "The Milky Way."
	a-k. Develop the following vocabulary terms: diffusion, eclipse, illuminate, incondescent, luminous, opaque, penumbra, photon, ray, reflection, spectrum, translucent, umbra, energy, fuel, gravity, nuclear reaction, prism.
a. The sun is only one of billions of stars.	a1. Examine photos or charts of the universe and Milky Way to determine the relative position of the sun and the vastness of the universe.
b. The sun is the star closest to the earth.	b1. A phenomenan known as parallax, the seeming change in the position of a star due to a change in position of the observer, can be used to measure distances. For additional details and illustrations, see A Sourcebook for Elementary Science, pp. 158-160.
c. The sun is the central body of the solar system.	c1. Make a chalkboard diagram of the sun and the planets. Use the following measurements:

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES

Body	Diameter	Distance
Sun	27"	--
Mercury	1/8"	1-3/4"
Venus	1/4"	3-1/4"
Earth	1/4"	4-3/4"
Mars	1/8"	7"
Jupiter	2-3/4"	2'
Saturn	2-3/8"	3' 8"
Uranus	1"	7' 5"
Neptune	7/8"	11' 8"
Pluto	1/8"	15' 3"

CONCEPTS	ACTIVITIES AND RESOURCES
d. The sun is much larger than the earth.	d1. Show how much larger the sun is than the earth. Draw two circles on the chalkboard, one with a diameter 13-5/8" wide and the other with a diameter 1/8 " wide. The diameter of the larger circle, labeled sun, will be 109 times larger than the smaller circle.
e. The sun appears to move across the sky.	e1. Experiment with paths of moving objects as observed from various frames of reference. Ask someone to plot the path of a child on a ferris wheel as observed by: 1. his parents on the ground. 2. friends three cars away in the wheel 3. himself 4. friends on a nearby merry-go-round.
f. When an object blocks the path of the sun's light, a shadow is produced.	f1. Let a source of light represent the sun. The source of light can be a slide projector. Get a globe of the earth and position the globe and light source so that the light falls evenly on the globe when the room is darkened. Let a tennis ball represent the moon. Hold the tennis ball between the "sun" and the "earth" so that a shadow falls on the "earth." Observers on earth in this shadow would see a solar eclipse.
g. The sun is a ball of hot gases.	g1. Discuss the parts of the sun: the hot gases that make up the body of the sun, the layer of the photo sphere, the red chromosphere above it, and the silvery corona surrounding the chromosphere. Look for a photograph of a solar eclipse that shows the corona quite clearly. Also, look for photographs showing sunspots and solar prominences.

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
h. The sun is the primary source of energy for the earth and the other planets.	h1. Make a chart showing the relationship of the sun to all living things.
i. The energy of the sun comes from nuclear reactions that take place inside the sun.	i1. Use mathematics to show that when four atoms of hydrogen are combined to form 1 atom of helium some units of matter are not accounted for and are released as energy in the forms of heat and light.
j. The sun gives us light.	j1. Get a globe of the earth that rotates. This globe will represent the planet Earth. Find out exactly where on the globe you live, then either put a mark or tape a small cutout figure on this spot. Spin the globe slowly from west to east. The part of the earth where you live will go from day to night and back to day again.
k. The sun warms the earth.	k1. Take two ice cubes-put one in the sunlight and one out of the sunlight. Measure each cube every five minutes and observe which one melts faster.
	k2. Use five pairs of objects such as pencils, books, etc. Place one of each pair in direct sunlight, the other in a shady place. After thirty or fourty minutes, have the children feel the objects to compare the temperature. Discuss the reasons for observed differences.

GEOLOGY

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-p. See T. E., Today's Basic Science 6, Harper and Row, 1967, pp.92-109.
	a-p. Show the following filmstrips; "Soil Resources", "Forest Resources," "Wildlife Resources," "Water Resources", "Mineral Resources," "Nature Cooperates With Man," "Waste of Our Resources," "Need for Conservation," "Water and its Conservation," "Soil and its Conservation," "Conservation of our Forests," "Conservation of Wildlife," "Conservation of Minerals."
	a-p. Develop the following vocabulary words; acid, alkali, arable, bedrock, conservation, contour, crop rotation, extinct, humus, inorganic, legume, loam, nodule, organic, refuge, sanctuary, selective cutting, soil profile, subsoil, terracing, topsoil.
a. Soil is a mixture of rocks and organic matter.	al. Get a handful of soil. Examine it under a magnifying glass. List all the identifiable materials seen. Obtain a soil sample 2 feet into the earth. Compare both kinds of soil for quantities of humus, pebbles or stone.
b. The earth's cover consists of layers.	bl. Make a soil profile by putting a cupful of soil into a jar. Pour water into the jar. Mix the water and soil. Stir the mixture with a spoon. Allow the soil to settle.
c. Rocks wear away and become part of the soil.	cl. With a can opener remove the top and bottom of a tin can. Cover one end of the can with a piece of cotton cloth or several layers of cheese cloth, and fasten the cloth securely to the open end of the can. Fill the can with crushed limestone and while holding the can over a shallow saucer, pour distilled water or freshly collected rainwater into the can. Collect

CONCEPTS	ACTIVITIES AND RESOURCES
	a sizeable quantity of the water, that has passed through the can and fallen into the saucer. Place the saucer, together, with another saucer of the same size and containing an equivalent amount of distilled water or rainwater, in a quiet place. Allow to evaporate. Pan with limestone water will leave behind a deposit.
d. Plants take water and minerals from the soil.	d. Fill two flower pots with the same type of soil. Plant a coleus plant in each pot. Obtain some commercial fertilizer for house plants. Mix the fertilizer with water. Give one coleus plant some fertilizer. Do not give fertilizer to the other plant. Observe the growth of each plant.
e. Earthworms turn the soil and make it arable.	e. Build an earthworm observation cage, or "wormery." To make the cage, first assemble a wooden frame. Use a piece of wood for the bottom of the cage. Use panels of glass for the sides. Tape the glass to the frame. Fill the cage with some garden soil. Put several earthworms into the cage covered for several days with a piece of paper. Then remove the paper. Note the tunnels they have made.
f. The erosion of wind and water carries away topsoil.	f. Fill three pans with soil of the same type. Plant grass seed across one pan in rows. Plant grass seed lengthwise, in another leave the third one bare. Allow the grass to grow. Tilt each pan and sprinkle with water. Note the holding quality of the grass planted in different directions with the bare soil.
g. Topsoil is protected through soil-conservation practices.	g. Have children do library research on contour farming, strip cropping and terracing.
h. Water is a natural resource.	h. Examine and discuss water distribution map on page 173, Today's Basic Science 6, Harper & Row, 1967.

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
i. Although water covers 70 per cent of the earth's surface, it is not evenly distributed.	i1. Develop a chart listing ways to conserve water, reuse water and how to gain new sources of water for use by man.
j. The wise use of forests is closely related to the wise use of soil and water.	j1. Arrange with the local park board or conservation service to participate in the planting of trees, shrubs, and flowers. Ask a nursery man to explain the rules for planting and caring for flowers, trees, shrubs and grass.
k. Trees are used for food, shelter and clothing; they are important to us in many ways.	k1. Develop a class chart on uses of trees under food, shelter and clothing.
l. Insects, fires and wasteful lumbering are a threat to our forests.	l1. Have your class write to the U.S. Forest Service, Department of Agriculture, Washington, D.C. for free materials to be used in the study of forest conservation.
m. Various animals have disappeared from the earth.	m1. Have children do reports on extinct animals.
n. Animals should be protected; they help to maintain the "balance of nature."	n1. Use children's reports to complete charts referring to the law of adaptation, law of succession, law of multiplication, and law of control.
o. Minerals are nonrenewable resources.	o1. Have a boy or girl prepare a report on the mineral consumption in the United States (available from encyclopedia yearbooks.) Emphasize that minerals are non renewable and the problem of conservation becomes one of getting the greatest use out of these resources.
p. Minerals are not evenly distributed on the surface of the earth.	p1. Use social studies texts to locate distribution maps of the earth's mineral resources.

OCEANOGRAPHY

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-g. See T. E., Science for Today and Tomorrow 6, D. C. Heath, 1968, pp 586-592.
	a-g. Develop the following vocabulary; seawater, plankton, currents, ocean, core sampling, transducer, ridge, rift, sediment, marine zoologist, aquarium, bathyscaph, diatom.
a. The ocean bottom has hills, mountains, valleys, clifts, and volcanoes.	a1. Make a clay model of the ocean floor showing different physical features.
b. Sediment from the ocean floor gives clues to the earth's past.	b1. Obtain a core sample from a pond using a see through plastic tube or make your own sediment sample in a can by stirring soil in water and allowing it to settle for a few days. Use a glass tube to secure a core sample.
c. The chemical composition of seawater is much the same in all oceans.	c1. Obtain samples of residue from the evaporation of ocean water from a school located near the sea. Attempt to reconstitute the ocean water by adding the proper amount of clear, fresh unchlorinated local water.
d. Animals from the ocean depths cannot live in shallow water.	d1. To show that animals of the ocean need pressure to live, blow up a balloon to capacity and put it into a bell jar in which a vacuum can be produced. Start the vacuum pump machine. Eventually the balloon will explode. Explain that this would happen to fish which normally live deep under the ocean's surface if brought to the surface quickly.
e. Most of the animal life of the sea is dependent upon tiny living things called plankton.	e1. To test the multiplication of plankton, add some to an aquarium full of water. Check the increase once each week. A good descriptive record from week to week will be a better basis for comparison than memory.

CONCEPTS	ACTIVITIES AND RESOURCES
f. Ocean currents are traced by several methods including floating markers, radio transmitters, and dyes.	f1. Introduce your class to Kon-Tiki, a book which has vivid descriptions and explanations of currents off the west coast of South America. Read selected passages to the children.
	f2. See ocean current map on p. 357 of Science for Today and Tomorrow, D.C. Heath, 1968.
g. Ocean currents are influenced by differences in density of temperature of the water.	g1. Color a glassful of warm water with a few drops of ink. Gently place an ice cube on the surface near one side of the glass. Observe the underside of the ice cube. The cooled water will sink.

E.S.S. UNIT
GASES AND AIRS

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
a. Although air is invisible, it is real and takes up space.	a-f. Suggested film loops; "The Mouse and the Candle", "Candle Burning I," "Candle Burning II, Candle Burning Techniques." a-f. Teacher Training Film showing a sixth grade class working through Section III of Gases and Airs is available at your nearest Webster Division, McGraw-Hill Book Company office. a-f. See Teacher's Guide for, Gases and Airs, McGraw-Hill and company, 1967.
b. Oxygen is a very active gas and combines with many materials. The combination of wet steel wool and air produces rust.	
c. The air pressure inside a container can be changed by heating or cooling the container.	
d. Air is a mixture of many gases. (78 percent nitrogen, 21 percent oxygen, and 1 percent other gases.)	
e. Oxygen is used when burning takes place.	
f. Living things need oxygen from the air to live.	

WATER, WEATHER AND AIR

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-p. See T.E., Today's Basic Science 6, Harper & Row, 1967, pp 22-47.
	a-p. Show the following filmstrips; "The Weather Powerhouse," "Adventures of a Raindrop," "Our Ocean of Air," "Whirling Winds," "World of Clouds," "Thunder and Lightning," "Weathermen at Work," "Changing the Weather," "Weather Folklore."
	a-p. Develop the following vocabulary words: altocumulus, altostratus, atmosphere, calibrate, cirrocumulus, cirrostratus, cirrus, condensation, convection, cumuliform, cumulus, cyclone, evaporation, exosphere, front, hurricane, hydrosphere, hygrometer, ion, lithosphere, nimbostratus, ozone, precipitation, psychrometer, radiation, relative humidity, solar, stratiform, stratocumulus, stratosphere, stratus, tornado, troposphere, typhoon, ultraviolet.
a. Air is a mixture of gases.	a1. To show one of the gases in the air stand a beaker in a shallow pan. Fill it half full of water. Add a tablespoon of baking soda and stir it until it dissolves. Pour a little vinegar into the baking soda solution. Bubbles will be formed at once. While the liquid is still foaming, hold a burning paste stick just above the foam. It will go out because carbon dioxide is given off when baking soda, water and vinegar are mixed.
b. The sun radiates energy in the form of heat and light.	b1. Place thermometers in the sunlight and the shade to show difference in temperatures.
c. The earth reflects some of the heat from the sun back into the atmosphere.	c1. To show the "greenhouse effect" set up the following experiment. Place a four-inch layer of soil in each of two large boxes.

CONCEPTS	ACTIVITIES AND RESOURCES
	Lay a thermometer across the soil in each box. Cover one box with transparent plastic or a large sheet of glass. Place both boxes outdoors in a sunny area. Record temperatures every 15 minutes. Prepare a graph of the reading.
d. The atmosphere is divided into four layers: the troposphere, stratosphere, ionosphere, and exosphere.	d. Draw a diagram of the layers of the atmosphere. Find the ground temperature and using the information found on page 40 of Today's Basic Science 6, Harper & Row, 1967, figure temperatures as you go out into the earth's atmosphere.
e. Hot, equatorial air rises and moves tuward the poles. Cold air at the poles hugs the ground and moves toward the equator.	e. Study the diagram on page 46 of Today's Basic Science 6, Harper & Row, 1967.
f. The circulation of air is broken up into wind belts.	f. Use a globe to locate the westerlies, trade wind and horse latitudes, and polar winds. Place signs bearing the names of these belts on the globe. Use plasticine or nonhardening clay to hold the signs in place. Attach arrows along side the signs to indicate wind directions.
g. Differences in the temperatures of land and water cause local movements of air.	g. To show differences in temperature changes fill one pail with sand, another with water, and the third with the grass-covered soil. Place a thermometer in each pail. The bulb of the thermometer should be about one-half inch below the surface of the sand, soil, or water. Suspend the thermometer in the water with a string. Place the three containers outside. Expose them to the sun. Leave them in the sun for one week. If possible, take a reading each hour throughout the day. Compare the temperatures when your record is complete.
h. An object becomes cool as a liquid evaporates from it; evaporation has a cooling effect.	h. To show that evaporation cools use some cotton to make a wick. Place this into a bottle of water, place a thermometer into the moist cotton and observe the drop in

CONCEPTS	ACTIVITIES AND RESOURCES
	temperature. Be sure water is the same temperature as the room.
i. Humidity is the amount of moisture in the air.	i. Use a dry-bulb and a wet-bulb thermometer. Determine the difference in temperatures and then using the chart on page 57 of Today's Basic Science 6 Harper and Row, 1967, figure relative humidity.
j. Rising, expanding air gives up heat; the temperature of the rising air falls.	j1. See pages 59-60 of Today's Basic Science 6, Harper & Row, 1967.
k. Water vapor in the air condenses when the air cools to a temperature known as the dew point.	k1. Pour hot water into a glass and fill another glass with ice. Do not allow the glasses to become wet on the outside when you fill them. As the air is cooled it will give up its moisture on the outside of the glass filled with ice.
l. Cold air is heavier than warm air.	l1. Cut a spiral ribbon out of a sheet of paper. Suspend the paper spiral over a hot plate using the string and a stick. Note the rising hot air to turn the spiral ribbon.
m. A front develops when one air mass moves against another air mass; there are warm fronts and cold fronts.	m1. Listen to the weather reports. When a cold front is moving into your area, observe the sky. Make a record of what you see. If possible take photographs of the sky at various times during your observations.
n. A cloud consists of tiny drops of water.	n1. Make a cloud chart. Use the chart to keep a record of clouds you observe. What types of clouds do you see in your sky? From which direction do these clouds come: What kind of weather does each cloud type bring?
o. Precipitation falls from a cloud.	o1. To show the rain cycle fill a pyrex pot with water and heat the pot on a hot plate until the water is boiling vigorously. Fill a pie tin with ice cubes and, while using a potholder or cotton glove, hold the pie tin about 6 inches above the pot. A miniature water cycle will be produced as the water vapor from the boiling water is cooled by the cold bottom of the pie tin, causing droplets of water to condense on the bottom

CONCEPTS	ACTIVITIES AND RESOURCES
	of the tin and then drop back into the water.
p. Tornadoes and hurricanes are violent storms.	p1. Show filmstrip; "Weather: Understanding Storms."

PLANES, ROCKETS AND SPACE TRAVEL

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-p. See T. E. Today's Basic Science 6, Harper and Row, 1967, pp 68-87.
	a-p. Show the following filmstrips/ "Man Learns to Fly," "Man in Flight," "Man in Space," "Flight into Space," "Flight Around the Moon," "Flight to Mars," "Pioneers in Space," "Exploration of Space," "Aviation in the Space Age," "Conquest of Space," "Man Travels in Space," "Hazards in Space Travel," "Stations on the Moon."
	a-p. Develop the following vocabulary; centrifugal force, clustering, combustion, elliptical, escape velocity, exhaust, velocity, fuel, gravity, igniter, inertia, mass ratio, oxidizer, propellant, satellite, speed, step principle, velocity, weightlessness.
a. A rocket is jet-propelled.	a1. Make a bulletin board display showing various aircraft and rocket engines.
b. For every action, there is an opposite and equal reaction.	b1. To show rocket thrust obtain a carbon dioxide capsule and spring plunger from a hobby shop. Fasten the capsule to the toy car. Tie it securely with string. Place the car on the floor. Now puncture the capsule with the plunger.
c. A rocket can function in space because it carries its own supply of oxygen.	c1. Place a candle in a pint jar. Light and place a metal plate over top of jar. Find out by watching a clock with a second hand how long the candle continues to burn. Do the same with a quart jar. Note that the candle will burn about twice as long in the quart jar because it contains about twice as much oxygen.
d. Some rockets use liquid propellants; others use	d1. Draw pictures of rocket engines and label the propellants. Discuss the advantages

CONCEPTS	ACTIVITIES AND RESOURCES
solid propellants.	and disadvantages of the state of the propellants.
e. A rocket cannot soar into space unless it overcomes the pull of earth's gravity	e. Launch a toy rocket. Get a water-powered toy rocket, available in toy stores or in hobby shops. A jet of water propels the rocket. Launch the rocket. Note that it falls back to earth because of the pull of gravity.
f. A multistage rocket can attain escape velocity.	f1. Many rockets use several stages. What is the most frequent number of stages used? Find out. Make a note of the altitudes and speeds of each stage.
g. The force of gravity pulls an artificial earth satellite around the earth.	g1. Refer to the diagram on page 134 of Today's Basic Science 6, Harper & Row, 1967.
h. Centrifugal force tends to pull a revolving body away from the center ground which it revolves.	h1. To show centrifugal force whirl a heavy object on a rubber band. Note outward pull and force exerted. Whirl it slowly, then rapidly.
i. An object at rest tends to remain at rest; an object in motion tends to remain in motion.	i1. To show inertia put a file card on a table. Let half of the card extend over the edge of the table. Place a penny on the card. Now, flick the card with your finger. Give the card a quick, snapping blow. The card flies away. The penny remains at rest.
j. A rocket meets no resistance or friction in space.	j1. If possible obtain a television set for your classroom use during space activities. Note the absence of gravity.
k. High speeds are needed to put a satellite into orbit and to keep it there.	k1. To show how centrifugal force is related to the speed of an orbiting object do the following experiment. Place a string through the length of a small pipe. Tie a small stone to one end of the string. Tie a large stone to the other end of the string. Allow the large stone to rest on the floor. Hold the pipe in one hand. Whirl the small stone over your head. Use the pipe as a handle as you whirl the stone. Whirl the small stone faster and faster. Observe the results of increasing speed on the large stone.

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
l. A satellite falls into the atmosphere when it loses speed.	
m. Satellites have many practical uses.	ml. Have the children write to the Office of Educational Programs, National Aeronautics and Space Administration (NASA), 400 Maryland Avenue. S.W., Washington 25,D.C. They will receive NASA Facts, which is a bulletin issued periodically. In the bulletin there is detailed information on the different kinds of satellites, their function, what they have studied and measured, and what they have learned.
n. Astronauts must overcome many problems to survive in space.	nl. Have the children do library research on the following problems of survival the astronauts will encounter in space travel. These problems will include the tremendous force of acceleration and deceleration, weightlessness, food and water, sufficient oxygen, disposal of carbon dioxide and of body wastes, heat and cold, bombardment by cosmic rays and other deadly radiations, bombardment by meteors, and mental problems caused by prolonged isolation.
o. A person becomes weightless in space.	ol. Define and discuss the term "zero gravity."

E.S.S. UNIT

PLANTS - MICROGARDENING

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
a. This unit introduces children to the molds--a group of microscopic living things very different from the trees, shrubs, wild flowers, and other plants with which they are familiar. The unit makes use of printed materials, equipment for experiments, and color film loops to present a variety of materials for students to use in their study of the molds. The children working with Microgardening become familiar with principles and procedures that have contributed to man's knowledge and understanding over the past 200 years. The five areas of study covered in the unit are: What are molds like? What influences the growth of molds? Where do molds come from? What influences the rate of mold growth? What can molds do? These five sections are usually taught in two parts: Areas I and II in Grades 4-5, requiring five to seven weeks to teach; and Areas III, IV, and V in Grade 6 or higher, requiring an	al. See Teacher's Guide, Microgardening, McGraw-Hill Book Comapny, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES
additional nine to 12 weeks. Detailed suggestions for scheduling and class preparation are given in the Teacher's Guide.	

E.S.S. UNIT

ANIMALS - CRAYFISH

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
a. Crayfish are interesting and manageable animals to keep in a classroom. Children enjoy handling crayfish and investigating their behavior. They may be collected in most parts of the country at all times of the year or purchased inexpensively enough to give each pair of children an animal to work with. In most classes, the students decide upon a marking system, so they can identify their pets in a central pool. Many of the children's questions about crayfish can be answered by observation or by simple experiments. If they want to know what a crayfish likes to eat, they can offer it different kinds of food and see which it prefers or rejects. They can find out which crayfish in a pool are the strongest. They can see whether more than one will occupy a flowerpot "house" or whether each crayfish must have its own. They can set up different kinds of homes in the central pool or separate aquariums. They can see how crayfish	a1. See Teachers Guide, Crayfish, McGraw-Hill Book Company, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES
move and what causes them to come out of retreat.	
The children learn to recognize their own animals very quickly and become attached to them. They draw pictures of their pets, make sculptures of them, and write songs, poems, and stories to share with their classmates.	
Scheduling for this unit is flexible and depends upon the interests of a partucular class. Some classes have spent five to seven weeks on the unit, while others have kept crayfish in the classroom all year long for small groups of students to work with.	

ANIMALS

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-s See T.E., Today's Basic Science 6, Harper and Row, 1967, pp. 110-139.
	a-s Suggested filmstrips; "Learning About Mammals" "Learning About Birds" "Learning About Amphibians" "Learning About Reptiles" "Learning About Insects" "Some Water Animals" "Insects; Their Life Cycles" "Social Insects"
	a-s Develop the following vocabulary words: abdomen, allantois, ameba, amnion, amphibian, arthropod, bivalve, blastodisc, carnivcrous, cephalopod, cilia, crustacean, fry, gastropod, gestation, invertebrate, larva, maggot, metamorphosis, mollusk, ovipositor, paramecium, pelecypod, planarian, protoplasm, protozoa, pupa, spiracle, thorax, univalve, vertebrate, yolk.
a. Many animals begin life in an egg cell. b. An egg cell develops into a many celled embryo, or unborn animal.	a-b If this unit is studied in the spring season, collect some frog or toad eggs form a pond. Place them in an aquarium in which there is a constant flow of water and let students observe the development of the tadpoles.
c. The embryos of birds and some other animals remain in the eggs until they are hatched.	cl. Hatch chicken eggs in commercial or selfconstructed incubators. For directions on how to build an incubator see page 216, Today's Basic Science 6, Harper and Row, 1967.
d. The embryos of mammals grow and develop within the mother's body; the mother gives birth to a live baby.	dl. Observe the development and birth of guppies in a class aquarium.

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
e. The life spans of various animals differ.	e1. Have the children prepare charts on gestation periods and life spans of various animals of special class interest.
f. Animals are divided into large divisions--invertebrates and vertebrates.	f1. Prepare a bulletin board display of the animal kingdom as diagrammed on page 118 of the teacher's edition of, Today's Basic Science 6, Harper and Row, 1967.
g. Protozoa are one-celled organisms. h. There are many kinds of protozoa; two familiar kinds are the ameba and the paramecium. i. Ameba and paramecia reproduce through cell division; they simply divide themselves.	f-i Hay-infusion experiment. Put some dry grass or hay in a jar of water. Allow the jar with the grass to stand at room temperature for at least one week. Examine a drop of the water with a microscope or a microprojector. Note how the paramecia move about. One of these animals may be dividing itself. Observe the division
j. The lower invertebrates are many-celled animals and reproduce in three ways: by cell division, from an egg, or by branching (budding).	j1. Show film,"Sponges and Coelenterates; Porus Sac-Like Animals."
k. Worms have a well--developed structure and are grouped into three main types: flatworms, round worms, and segmented worms.	k1. Build an earthworm observation cage, or wormery. To make the cage, first assemble a wooden frame. Use a piece of wood for the bottom of the cage. Use panels of glass for the sides and tape the glass to the wood frame. Fill the cage with some moist garden soil. Put several varieties of earth worms into the cage. Keep the sides covered with dark paper except when observing them.
l. There are three main classes of mollusks; gastropod, pelecypod, and cephalopod. Most mollusks have protective shells; all have soft bodies.	l1. Observe a living clam as he obtains food materials and oxygen from the water. Water and the material it contains is pumped into one part of the clam's body and is ejected from another. The food and oxygen are removed by the clam within its body. The movement of this water into the clam can be seen if a drop of food coloring is placed

CONCEPTS	ACTIVITIES AND RESOURCES
	in the water at the edge of the clam's shell. This can only be observed when the shell is slightly open and the soft edge of the body is exposed. A soda straw can be used to bring the food color near the clam without disturbing it.
m. Arthropods are animals with jointed legs and an exoskeleton.	
n. An insect is an animal with a three-part body and six legs. Some insects go through a complete metamorphosis; others go through an incomplete metamorphosis.	m-n You can observe the life cycle of an insect in your classroom. You can see a fruit fly go through a complete metamorphosis. For directions on how to capture and keep fruit flies see page 207 of Today's Basic Science 6, Harper and Row, 1967.
o. Fish are vertebrates adapted for living in the water. Most fish are egg-layers, but some are known as live--bearers.	ol. Obtain a goldfish and place it in a small aquarium in which the water is at room temperature. Now put 3 or 4 ice cubes in the water. Stir and, after about 5 minutes, measure the temperature again. Observe the behavior of the fish. Now remove the ice cubes and slowly pour in a small amount of warm (not hot) water. Again, measure the water temperature and observe the fish's behavior. The activity of the fish will decrease markedly with the addition of ice; it will increase sharply as the water becomes warmer. This clearly illustrates the behavior of cold-blooded organisms.
p. Amphibians are cold-blooded animals with backbones who spend part of their lives in the water and part of their lives on land.	pl. Frogs and toads live very well in a terrarium. Place a frog and a toad in seperate cartons. Compare their appearence, skin, and color. Touch their skin and see if it is wet or dry. Compare the way they hop. Count the number of toes on each foot and see if the webbing between the toes is the same. Bring your finger close to their eyes and see if they wink. Introcuce live flies into each container and cover. Observe how the frog and toad use their tongues to catch and eat the flies.

CONCEPTS	ACTIVITIES AND RESOURCES
q. Reptiles are cold-blooded animals with backbones. Most reptiles hatch from eggs, but a few species bear their young alive.	q1. Show film, "Reptiles."
r. Birds are animals with backbones, have feathers, hatch from eggs and most can fly.	r1. Investigate the development of a chick embryo. Obtain a dozen fertile eggs. Keep them in an incubator. Open one egg every third day. Preserve the embryo in formaldehyde. Keep a record of how the embryo changes in appearance.
s. Mammals have backbones, females nurse their young, most are born alive, are warm-blooded, have hair on their bodies, and have four-chambered hearts.	s1. Keep and observe small mammals. White mice, guinea pigs, and hamsters are excellent small mammals to keep and observe in the elementary classroom. Have the children note and compare the physical characteristics and the living and feeding habits of each animal.

E.S.S. UNIT

MATTER - PEAS AND PARTICLES

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
a. This is a unit in which children deal informally with estimation and large numbers in ways that may be new to them. They answer questions--How many? How big? How far away?--not with worksheet or aritmetic--test precision, but as we tend to answer questions ordinarily, with estimates and "educated" guesses. Because the answers are approximations, the methods for reaching them can vary more widely than exact answer usually permits. Children bring their own experiences to bear on classroom problems and explore techniques they will find useful in school and out. They invent for themselves ingenious methods of counting even millions of objects in a short time. Most of the materials for this unit can be purchased inexpensively in any grocery store. They include such things as beans, rice, cereal, salt, macaroni, nuts, and potatoes. The children will progress from a question like, "How	a1. See Teacher's Guide, Peas and Particles, McGraw-Hill Book Company, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES
many peas can you hold in your hand?" to "How many grains of rice are there in a quart jar?" Children are ingenious when it comes to thinking of methods of counting and estimating large numbers. How important is rounding off? When is an exact answer needed? These are some of the questions that children discuss in the course of their work with Peas and Particles. The unit has been used effectively in Grades 3 through 8. It has taken about 15 class periods, though some children move more quickly or slowly.	

E.S.S. UNIT

MATTER - KITCHEN PHYSICS

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
a. In Kitchen Physics, the student examines liquids-how they form drops and puddles; how they fall and break up; how fast they flow through various sizes of openings; how they heap up, are absorbed, evaporate, mix, and dissolve. He assembles and used simple equipment, such as a balance, which he then modifies for use as a tensiometer. By investigating some properties of common liquids, such as water, soapy water, oil, alcohol, and syrup, the student can function much as the research scientist does. He will learn to observe, question, predict, design and perform experiments, collect and analyze data. The objective of this unit is for the child to acquire an awareness of the world of science, and a way of approaching and enjoying it that is compatible with his level of understanding and operation. The unit was designed for use in the fifth	a1. See Teacher's Guide, Kitchen Physics, McGraw-Hill Book Company, 1968.

CONCEPTS	ACTIVITIES AND RESOURCES
through eighth grades. The amount of time you give to the activities should depend upon the students' interest. Suggestions for scheduling are given in the Teacher's Guide.	

MATTER

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-m See T.E., Today's Basic Science 6, Harper and Row, 1967, pp. 201-220.
	a-m See T.E., Concepts in Science 6, Harcourt, Brace, and World, 1966, pp.92-151.
	a-m See T.E., Science for Today and Tomorrow 6, D.C. Heath, 1968, pp. 426-447.
	a-m Suggested filmstrips: "What is an Atom?" "What is Matter?" "What is Chemistry?" "Chemical Change"
	a-m Develop the following vocabulary words: chemistry, element, atom, molecule, compound, mixture, solution, suspension, solid, liquid, gas, nucleus, proton, electron, neutron, formula, acids, bases, cohesion, adhesion, chemical and physical change.
a. Matter is anything that takes up, or occupies, space and has weight. b. Matter is found in three forms, or states, called solid, liquid, and gas.	a-b Show that solids, liquids, and gases occupy space and have weight. Measure and weigh a block of wood. Pour water into a glass and then weigh separately. Using a balance beam and two balloons show that air has weight and takes up space. Blow up the balloons and balance them. Then deflating one balloon note the difference in weight.
c. Matter can be changed from one state to another by heating or cooling.	cl. Get some water in its solid state. Record the temperature at which it changes to the liquid state. Record the temperature at which it changes to the gaseous state. Repeat the experiment with some orange juice in its solid form. Do the changes of state occur at the same temperature as the water?

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
d. The science that deals with the different kinds of matter around us, of what they are made, and the changes that happen to them, is called chemistry.	d1. Show filmstrip, "What is Chemistry."
e. All of the substances of the world are made up of tiny moving particles called molecules. Molecules are made up of even tinier particles called atoms.	e-f Refer to pages 319-323 in, Today's Basic Science 6, Harper and Row, 1967.
f. An atom is composed of one or more particles called electrons, revolving around the same number of protons and (usually) one or more neutrons, clustered in a nucleus. A substance whose atoms are all of the same kind is called an element.	
g. Atoms of elements combine in definite proportions to form molecules of compounds. The atoms in a molecule are held together by a force called chemical bond.	g1. Study the formulas of some common substances such as water (H_2O), salt (NaCl). Use the following experiment to show how to make silver sulfide, a compound. Put a bit of cooked egg yolk in a small dish. This will provide the sulfur. Place the top of a shiny silver spoon in it. Leave it for an hour. The thin layer of black material is the compound silver sulfide.
h. There are two kinds of changes that can happen to matter: physical and chemical changes.	h-k See pages 15-20, Science for Today and Tomorrow 6, D.C. Heath, 1968.
i. There are several types of chemical changes; combining elements into compounds, separating	

CONCEPTS	ACTIVITIES AND RESOURCES
compounds into elements, and rearranging compounds into new compounds. In every chemical change there is an energy transfer in which energy is either given off or absorved.	
j. All molecules attract each other. The attraction that molecules of the same substance have for each other is called cohesion. The attraction that molecules of different substances have for each other is called adhesion.	
k. The amount of energy transferred in a chemical reaction is related to the strength of the chemical bonds involved.	
l. The action of an unknown substance, when combined with certain known substances, indicates its troup. Litmus can be used to test for acids, bases, and neutral substances, which are indicated by color changes of the litmus.	ll. Test for acids. Obtain blue litmus paper and an assortment of substances like the following: vinegar, lemon juice, soda water, ammonia, lime water, tomato juice, milk of magnesia, boric acid, sour milk, grapefruit juice, salt water, various colors of ink, sugar water, etc. Pour a small amount of each liquid into separate little paper cups. Dip the tip of a strip of blue litmus paper into each substance. Use a new strip of litmus paper each time, or cut off the used end of the old piece. Record your results.
m. Each element gives off its own color of light when heated sufficiently. By separating the mixture of colors given off by a vaporized and glowing	ml. Test elements for flame color. Hold a dime with a pliers. Wet the dime, touch it to salt, and then hold it in the flame. What color do you see? Note your observation. Do the same with boric acid, lime, borax, alum, baking soda, and washing

CONCEPTS	ACTIVITIES AND RESOURCES
compound, we can tell the elements of which it is made.	soda. Keep a record of other substances tested and their colors.

MECHANICAL, MAGNETIC, LIGHT, AND NUCLEAR ENERGY

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
	a-u See TE Today's Basic Science 6, Harper and Row, 1967, pp. 48-87, 180-220.
	a-u See T.E., Concepts in Scinece 6, Harcourt, Brace and World, 1966, pp. 72-91.
	a-u Suggested filmstrips: "What is Energy?" "Machines" "Magnets" "Light" "Man Discovers the Atom" "Our Friend the Atom" "What is a Magnet?" "What is Light?"
	a-u Develop the following vocabulary: energy, work, force, power, motion, friction, simple machines, magnet, lines of force, pole, combustion, diffusion, filament, luminous, opaque, photon, ray, spectrum, translucent, element, fission, fusion, nucleus, radioactive.
a. Machines may multiply force, increase speed, or change direction.	a1. Show the following films: "Machines Do Work" "Machines Help Us"
b. Most machines are modifications or combinations of a few simple machines. The simple machines are the screw, wedge, wheel and axle, pulley, lever, and incline plane.	b1. Refer to pages 153-179 of Concepts in Science 6, Harcourt, Brace and World, 1966.
c. Friction increases effort that must be applied and decreases speed (distance).	c1. Pull a piece of wood across different textured surfaces such as an oiled table top, sandpaper, aluminum foil, and wax paper. Use a spring balance to determine the amount of pull required. Keep a record of the results.

CONCEPTS	ACTIVITIES AND RESOURCES
d. Work is done only when an object is moved through a distance. Work is measured in terms of foot-pounds.	d1. Use the study section on pages 187-188 of Concepts in Science 6, Harcourt, Brace and World, 1966.
e. The amount of energy gotten out of a machine does not exceed the energy put into it.	e1. All machines transfer a force. Operate a variety of hand tools and kitchen appliances. In each case show how a force is exerted on the machine at one place, and then how the machine transfers this force to another place where the work is done.
f. There are natural and manufactured magnets.	f1. Get a piece of lodestone for the children to examine. You may obtain lodestone from a scientific-supply house. Magnetize a needle by stroking it with one pole of a permanent magnet from one end to the other fifty times. Move the magnet always in the same direction. Have the children build an electromagnet.
g. A magnet has a north-seeking pole and a south-seeking pole. Like poles repel; unlike poles attract.	g1. Allow children to explore the attractive and repelling properties of bar magnets.
h. A magnetic field consisting of lines of force surround every magnet.	h1. Put a bar magnet under a piece of cardboard about eight inches square. Sprinkle iron filings on the cardboard above the magnet. Tap the cardboard to help the iron filings arrange themselves.
i. The earth has a North Magnetic Polar Area and a South Magnetic Polar Area.	i-j For information on the earth's magnetic fields and compasses have the children read pages 93-104 of, Today's Basic Science 6, Harper and Row, 1967.
j. A compass needled does not point to true north; instead it aligns itself with the earth's lines of magnetic force.	

GRADE SIX

CONCEPTS	ACTIVITIES AND RESOURCES
k. The "molecular theory" and the "electron theory" have been suggested as explanations of magnetism.	kl. Have children do library research on topics and also read pages 104-109 of Today's Basic Science 6, Harper and Row, 1967.
l. Light can be natural or artificial. The sun is the prime source of light energy.	ll. Make a bulletin board showing how light was used in the old days. Compare this to the uses of light now.
m. In some instances, the "particle theory" explains the movement of light; under different circumstances, the "wave theory" seems to explain how light travels.	ml. For information on the theories of light movement have the children read pages 291-293 of Today's Basic Science 6, Harper and Row, 1967.
n. Light passes through a "transparent" material. A "translucent" material scatters light. An "opaque" material blocks the passage of light.	nl. Put pieces of glass, paper, and wood into the beam of a flashlight. Does the same amount of light pass through each material? Describe the difference in the way light passes through each material.
o. Shadows are formed because light moves in a straight line. A shadow has two parts: the "umbra" and the "penumbra."	ol. Examine a shadow around a window and point out that the "penumbra" is the lightest part and the "umbra" is the darkest part.
p. An eclipse of the moon occurs when the earth passes between the moon and the sun; the shadow of the earth then falls upon the moon. An eclipse of the sun occurs when the moon passes between the earth and the sun; the shadow of the moon then falls upon the earth.	pl. Have the children draw diagrams to illustrate the concepts of a solar and lunar eclipse.

CONCEPTS	ACTIVITIES AND RESOURCES
q. Light rays "refract" or bend, when they move at a slant from one medium to another medium. A change in speed causes light rays to refract.	q1. Put a coin into the bottom of a dish. Glue the coin in place with some melted wax. Now, stand back. Keep your eyes on the coin, but stand back far enough to allow most of the coin to disappear from view. Let the side of the dish hide most of the coin. Have a friend pour water into the dish.. What happens to the coin? Why does this happen?
r. A prism breaks up white light into the six spectrum colors of: red, orange, yellow, green, blue, and violet.	r1. Darken the room. Cover the windows with an opaque material. Put a small hole in your window covering. Observe the beam of white light that passes through the hole into the darkened room. Let the light pass through a prism. Look for a pattern of light on the wall. Adjust the prism to get the pattern.
s. Nuclear energy comes from matter being changed to energy. Albert Einstein discovered the equation that describes the relation between matter and energy, $E=mc^2$.	s-u Have the children do library research on atomic energy and also read pages 317-342 of, Today's Basic Science 6, Harper and Row 1967.
t. Atomic energy affects man in both harmful and helpful ways.	
u. When the nucleus of the radioactive atom splits apart and releases quantities of energy (fission), the combination of nuclei of atoms form the nucleus of a heavier atom which releases a great amount of energy (fusion).	